MINING CONGRESS JOURNAL

FEBRUARY 1960

MINING IN '59

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INTRODUCING THE BURRO

The First PERFECTED interwoven coal mine belt!

Like its namesake, U.S. Burro® Conveyor Belt needs no coddling. It's tough – all the way through. This INTERWOVEN belt has been perfected with the mine operator in mind and offers these features:

a) Exclusive engineered stretch control, **b)** any cover thickness available, **c)** widest operating temperature range, **d)** highest edge and lengthwise rip resistance. **e)** Excellent fastener holding ability, **f)** perfect troughability for easy training, **g)** lowest cost.

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VOL. 46 FEBRUARY 1960 NO. 2

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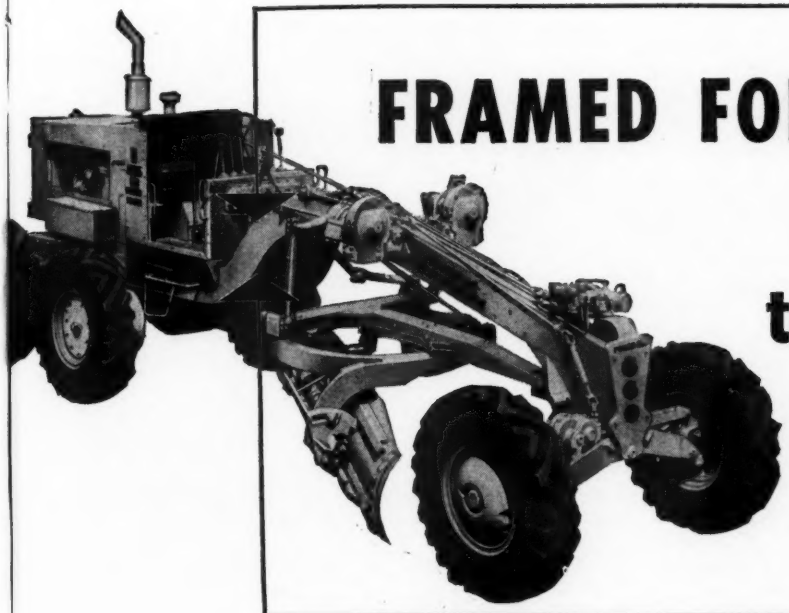


FRAMED FOR LONG LIFE

...to give you top performance on haul road maintenance

A strong, stable blade-foundation is essential if a grader is to give you high output. That's why LeTourneau-Westinghouse Adams* graders are given rugged, solid-strength, one-piece frames... that take all of the shocks, twists, and stresses of hardest day-to-day operating conditions.

Continuous-welded... front to rear

Front-to-rear members of the L-W main-frame are heavy steel U-channels. Up front, two full-length channels are welded together to form a box section. Channels separate at top of arch and become two boxes by addition of two heavy steel plates. Frame is continuous-welded from front bolster plate to boxed-in rear-end.

One major advantage of this boxed-channel framing is that it provides *maximum strength without excessive weight.* Result: with the L-W grader, more weight and strength can be built into important components, such as the big 63" L-W circle... none bigger in the industry... where size and strength mean better performance.

Steady blade-mount

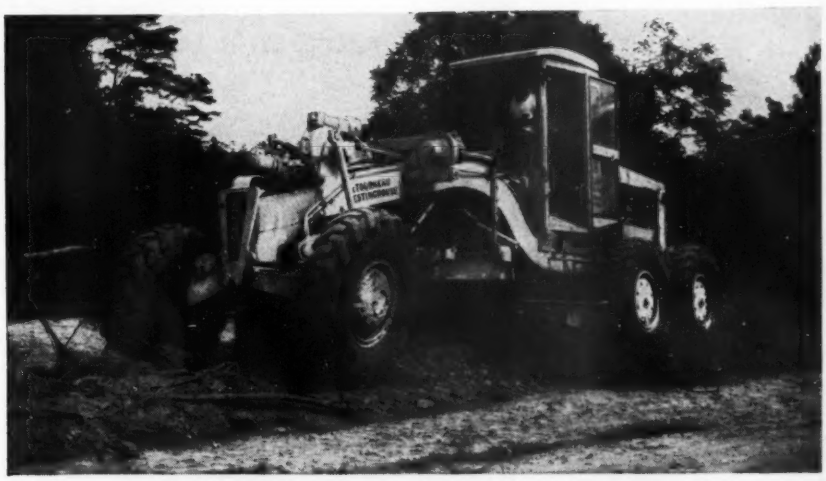
This unique L-W main-frame also provides a stable mount for the blade. No matter how tough the going, its solid strength assures a big bite... a smooth, precise finish-surface. No faltering when the blade hits heavy loads or hardpan... no "riding-up", or deflection.

Operator has clear view of blade

With circle-lift controls mounted forward on frame, both ends of blade are clearly visible to operator, *whether he's sitting or standing.* Clear view of blade assures more accurate grading... and more work done each day.

7 models... 67 to 190 hp

Let us show you any of the 7 high-speed LeTourneau-Westinghouse graders in action. We'll prove to you how these machines can grade faster... more accurately... at less cost. Ask for details and demonstration.



Unique, box-type, L-W Adams one-piece frame runs from front to rear without sharp bends... without joints... without breaking points. Seventy-three years of grader experience have gone into the development of this frame. It's the foundation for L-W grader's rigid, smooth-cutting qualities that get more work done fast... at lowest cost.

*Trademark G-1955-MQ-1

LW

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Model C-750 REICHdrill, Crawler-mounted.

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Model T-750 set-up for angle drilling, an exclusive REICHdrill feature. Units can be economically mounted on used highway trucks if desired.

And here are 4 rugged reasons why:

1. Variable rotation speed gives you exactly the right RPM for any material, rock to rubble.

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3. All controls actuated by smooth hydraulic power, saving operator time and tiring.

4. Extra heavy-duty construction on all component parts, including pumps, gears and frame means rig can take long, high speed duty without costly maintenance. Plus other field-proven features like hydraulic stem loader and down-the-hole hammer.

Units can be supplied truck or crawler mounted to suit operating conditions. Hole up to 12″ diam. Down pressure to 75,000 lbs. Write for detailed information on REICHdrills.

REICHdrill *Division: Chicago Pneumatic Tool Company*

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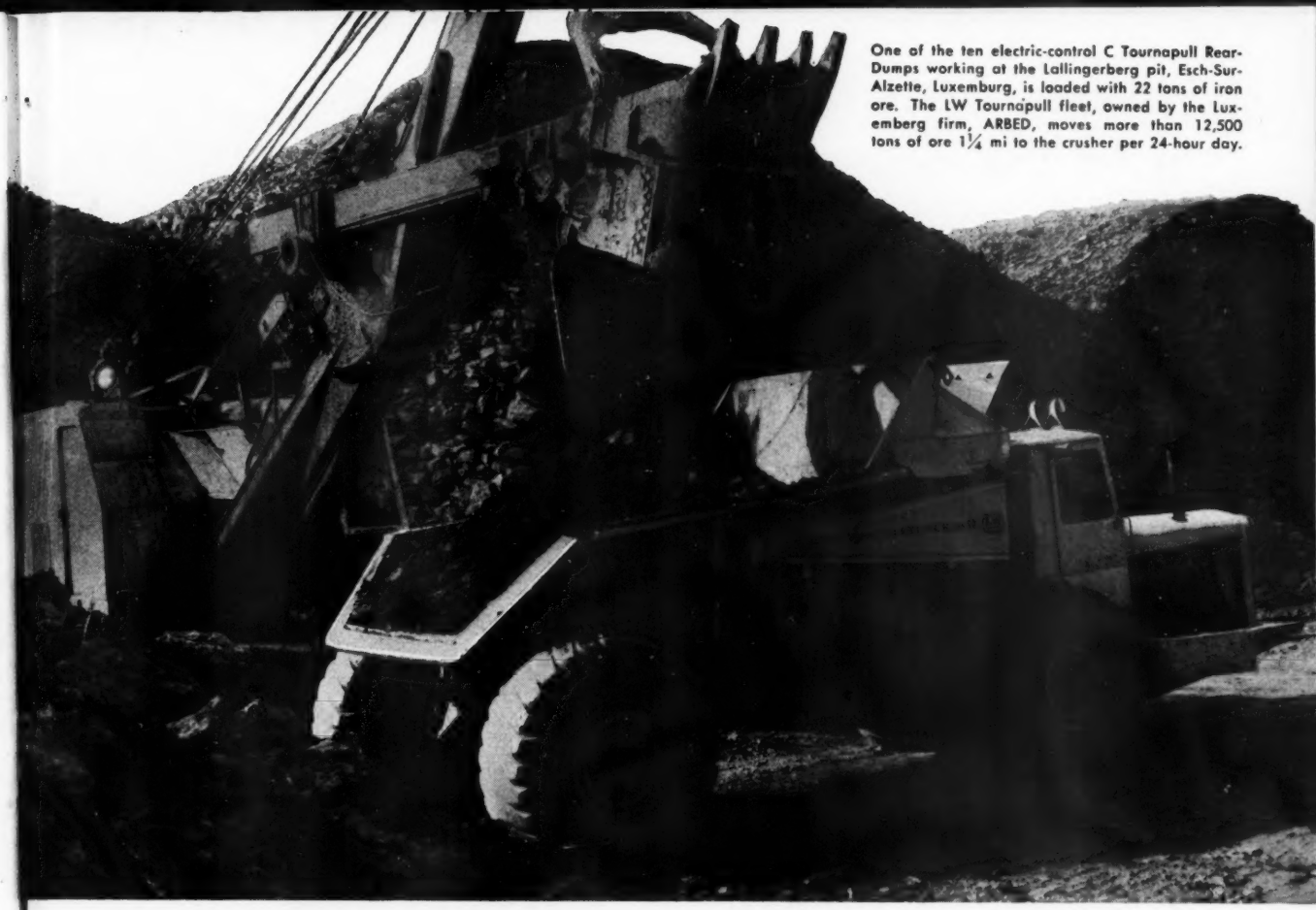

One of the ten electric-control C Tournapull Rear-Dumps working at the Lallingerberg pit, Esch-Sur-Alzette, Luxemburg, is loaded with 22 tons of iron ore. The LW Tournapull fleet, owned by the Luxemberg firm, ARBED, moves more than 12,500 tons of ore 1¼ mi to the crusher per 24-hour day.

• Works more productive hours

• Moves more tonnage

• Lowers costs

Rugged, simplified construction is one big reason why LeTourneau-Westinghouse Tournapull® Rear-Dumps keep working efficiently day after day, year after year, to help pit owners cut costs. Check these important LW Rear-Dump features:

• **Heavy-duty bowl** — has triple-layered steel floor to resist heaviest loading jolts. Sloping sides deflect load shock, quickly cushion floor area with layer of material.

• **Front-wheel drive and electric kingpin steer** — eliminate a great number of trouble-causing parts. No longer must power be carried back to the rear through a long drive-shaft, with its bearing, universal joint, and lubricating problems. And no longer is steering handled by small front wheels subject to misalignment as they try to get out of ruts.

• **Big, low-pressure tires** — absorb the shocks of off-road travel and shovel loading, eliminate the need for springs.

• **Electric-control system** — is never affected by excessive heat, cold, moisture, or dust. Point-of-action electric motors keep cable requirements low.

• **Exclusive power-transfer differential** — reduces costly wear on tires, clutch, and transmission caused by spinning wheels in slippery or loose footing — lets you work in difficult conditions where other competitive units bog down.

Advantages like these — plus short radius turns, fast, clean dump, giant air brakes, excellent visibility — add up to high production and low costs.

LeTourneau-Westinghouse Rear-Dumps are available in 3 sizes: 11, 22, and 35 tons. LW scraper, bottom-dump, and crane trailing-units are interchangeable behind the same Tournapull prime-mover. Ask for complete details.

CR-2076-MJ-1

LW

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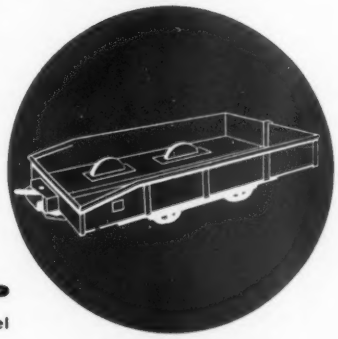
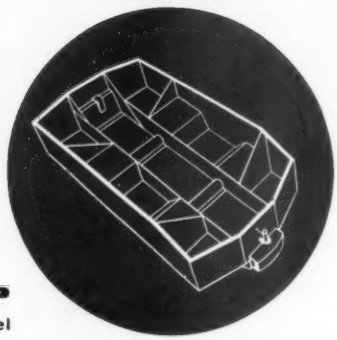
A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

DROP BOTTOM
4 wheel or 8 wheel



END DUMP
4 wheel



ROTARY DUMP
4 wheel or 8 wheel

acf MAKES ALL THREE

No matter what type of car your mining operations call for acf has a car to fit your needs. acf mine cars are built in all types and sizes from 2 to 30 tons, or more.

For safety, low maintenance and high speed constant haulage all acf mine cars have special features developed through many years of experience in design and manufacture.

Anti-friction bearings in the load-support wheels permit safe high speed from loading point to unloading point and back again for more. Automatic couplers make car handling safer and faster. acf double-action spring bumpers lower maintenance on everything from trackage to locomotive...provide smoother, safer hauling.

For complete information about the full line of acf Constant Haulage Mine Cars in all sizes and types contact the nearest acf sales office or discuss your haulage problems with one of our sales representatives.

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Nearly 700 acres in this pit

. . . but fast LW tractor works every "corner" of it

At the Keigley Quarry, Payson, Utah, about 700,000 tons of limestone and dolomite are produced per year. On this nearly 700-acre site — owned by the Columbia-Geneva Steel Division of United States Steel Corporation—a LW Tournatractor® handles a wide variety of jobs. This LeTourneau-Westinghouse rubber-tired dozer cleans up around shovels, maintains stockpiles, sometimes strips overburden, pushes railcars, tows compressors . . . and maintains 10 miles of roads!

Travels up to 30 mi per day

One of the main reasons this single Tournatractor can handle *all* these jobs for Keigley Quarry, is its ability to *run* from one assignment to the next. There's no time lost "crawling" between locations. During a normal work day at the big quarry, this 17-mph LW tractor travels a total of 25 to 30 miles.

Maintenance costs for Tournatractor are relatively low, too. The quarry reports, for instance, that in the past year it never had the tires off their rims. LW tractor's 4 big low-pressure tires absorb the shock of rough travel. In addition, with sealed, anti-friction drive, there's no danger of dust and grit entering and damaging moving parts.

Get the rest of the Tournatractor story from your LW Distributor. Let him give you the *facts* on how this 218-hp rubber-tired dozer boosts output and cuts pit costs.

Cleaning up around shovels is one of many jobs handled by this 218-hp LW Tournatractor working at the nearly 700-acre quarry near Payson, Utah. This mobile, 17-mph dozer on rubber saves you cost of multiple crawler-units because of its ability to hustle over a wide area in a few minutes.

CT-2104-MQJ-1

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to create
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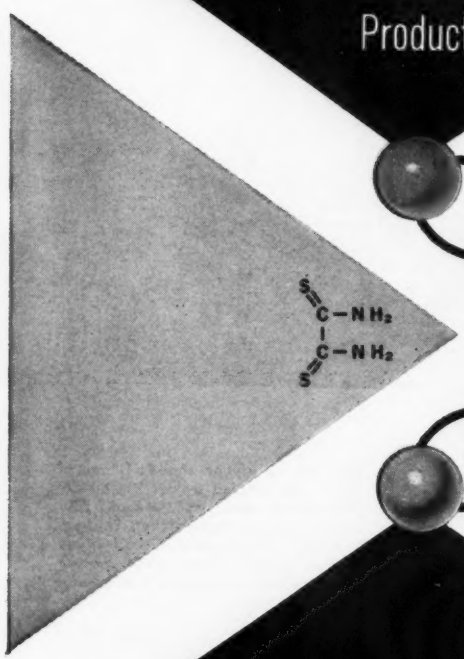

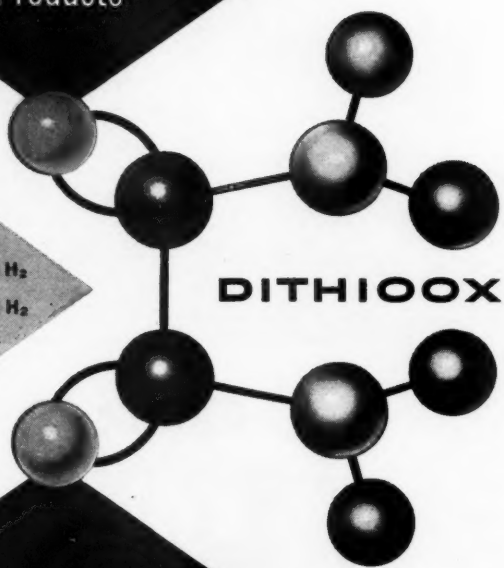

DITHIOOXAMIDE

Mallinckrodt Chemical Works, St. Louis, Missouri, recently announced this new building block...a chemical that can go in many directions to create new and better products. For example, the manufacturer suggests applications for dithiooxamide and its derivatives in the fields of metal sequestrants, pigments, organic intermediates and plant growth regulators.

A new building block with many potentials ...and as with so many such chemicals, Sulphur is a key ingredient!

Our business is to produce Sulphur ...to keep adequate supplies on hand at our production units...to deliver it in solid form by rail, barge or ship; in molten form in trucks, tank cars, barges, or ships. All of the properties listed below can supply both solid and molten Sulphur.

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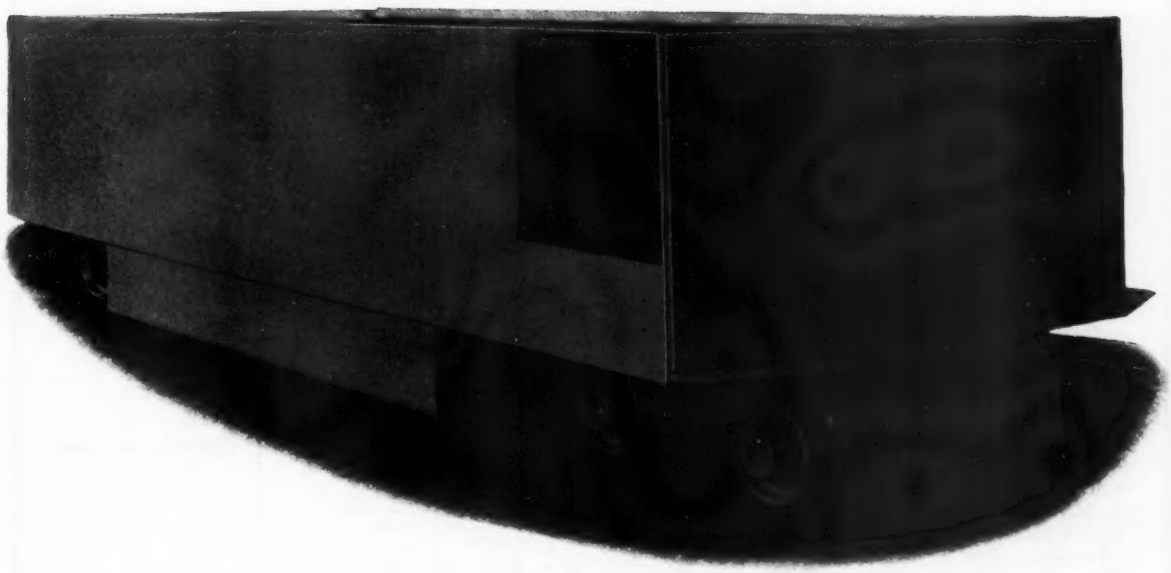
Sulphur Producing Units: Newgulf, Texas • Spindletop, Texas • Moss Bluff, Texas • Fannett, Texas • Worland, Wyoming • Okotoks, Alberta, Canada

LOW

but we didn't skimp on capacity



Bethlehem built this car for a customer with a problem. He needed a low car, and he didn't want it excessively long. Yet, at the same time, there had to be plenty of capacity. Bethlehem engineers worked up a design that filled the bill completely.

The finished car stands only 4 ft above the rails. Its inside length is 16 ft 6 in. Capacity (level), 390 cu ft; with 6-in. surcharge, 446 cu ft. Nominal load capacity, 11 tons.

Equipment includes automatic couplers, spring draft gear, forged-steel wheels, and fabricated trucks with roller bearings. Body parts in contact with the lading are corrosion-resistant steel.

When you decide to expand your own fleets of cars, let Bethlehem quote you. We are set up to construct any welded or riveted model for end-dump or rotary-dump service. Details of design and engineering can always be worked out to meet your requirements.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

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THE DUTCH STATE MINES HEAVY MEDIUM CYCLONE WASHER

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ROBERTS & SCHAEFER

THE ONLY WORLD-WIDE PROVED SYSTEM

Cleans Fine Coal Cleaner Than Any Other Cleaning System

With a Dutch State Mines Heavy Medium Cyclone Washing System, you get, from Roberts & Schaefer, these exclusive benefits: The technical knowledge of Dutch States Mines engineers, their experience with successfully operating plants in many countries, and the continuing collaboration of their technical organization with the R & S staff on installations in the United States.

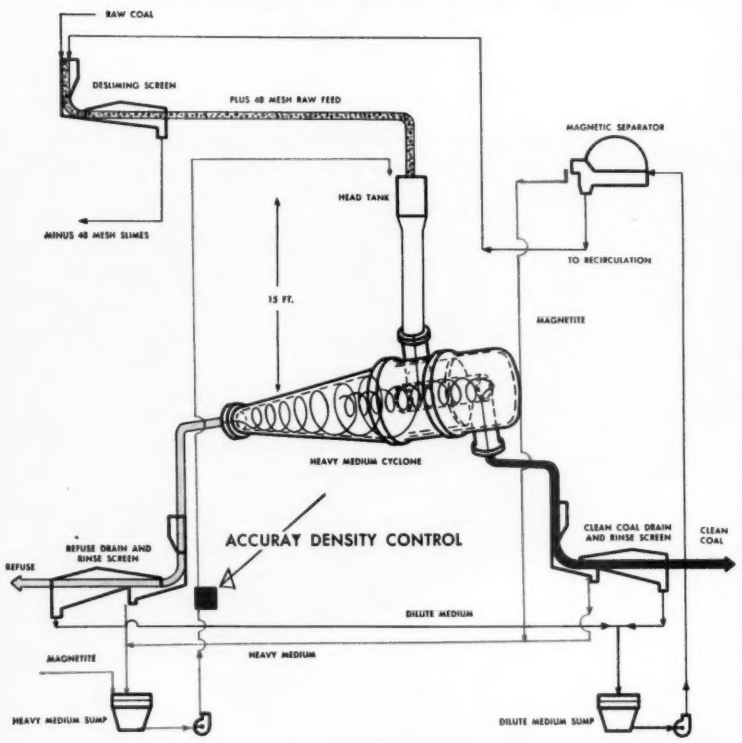
In its own full-scale pilot plant, Roberts & Schaefer has tested many American coals and proved the consistently superior efficiency of the system.

The first commercial Heavy Medium Cyclone Washing Plant in this country, engineered and built by Roberts & Schaefer, is now in operation and others will come on stream in coming weeks.

Roberts & Schaefer takes full responsibility with its own technical staff for engineering, installation and construction of its Heavy Medium Cyclone Washer Plants.

Installations can be made in your present facilities as well as in a completely new plant. Call or write us for detailed information.

FLOW DIAGRAM OF HEAVY MEDIUM CYCLONE WASHING SYSTEM



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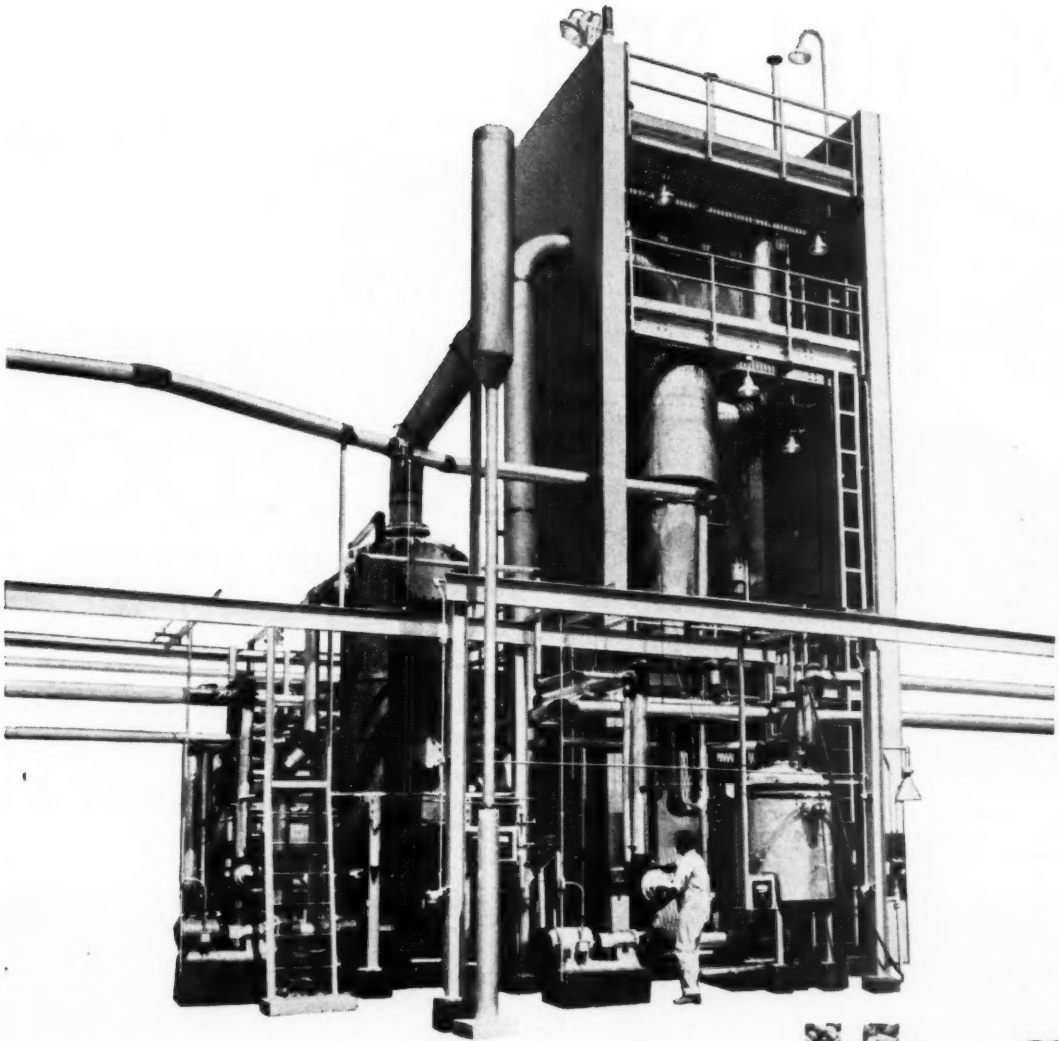

Now Ammonium Nitrate in pellets

New $5,000,000 Atlas Plant
Produces Unique, Improved Blasting Agent

Atlas is now producing low cost Ammonium Nitrate in a new pelleted form designed especially for blasting. Atlas Pellets give oil absorption equal to prills, and flow freely for fast loading into all types of blast holes. The new blasting agent is being made in the new $5 million Atlas acid and ammonium nitrate plant near Joplin, Mo.

Not a granule, not a prill, Atlas Pellets are porous but compact particles which, when oiled, have both the density and sensitivity required for efficient low cost ammonium nitrate blasting. They are the latest advance in developing new products and techniques to help the user of explosives gain lowest possible blasting costs. Your Atlas representative can help you put these products and techniques to profitable use in your operation.

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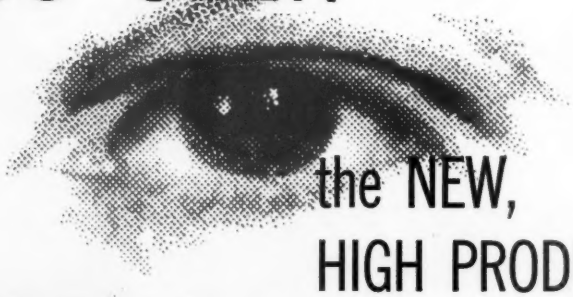


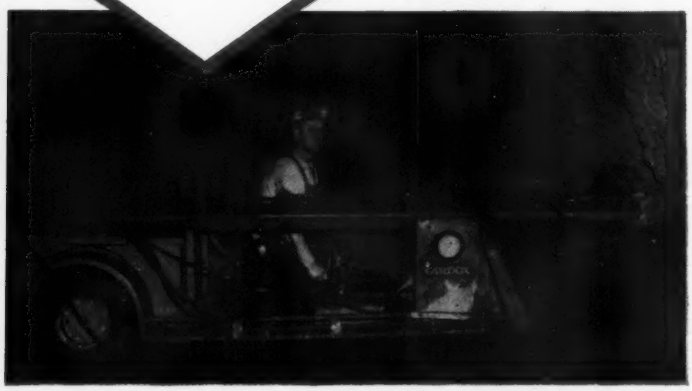
the NEW, HIGH PRODUCTION

AIRDOX®

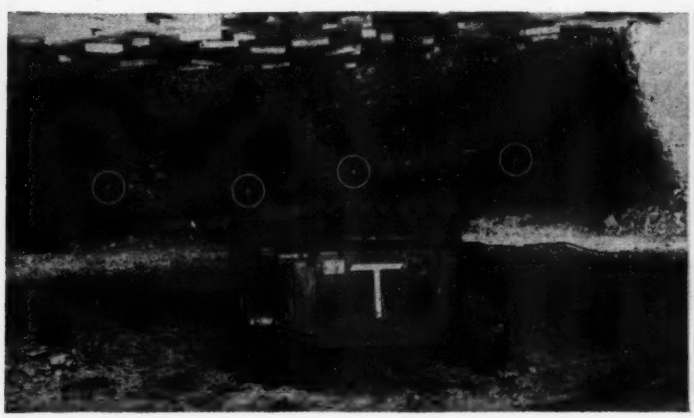
MOBILE MULTIPLE SHOOTING

NON-EXPLOSIVE MINING SYSTEM

HOW the new AIRDOX Mobile Multiple Shooting System Operates



1/ Shooter drives the AIRDOX Shooting Car to the face. All AIRDOX Tubes, High Pressure Hose and Sequence Valve are carried on the car, which may be operated under roofs as low as 30".



2/ AIRDOX Tubes are placed in holes. Note four tubes in lower row of holes in face, with other rows of holes above.

3/ With AIRDOX Tubes in place and high pressure hose connected, shooter discharges first row in correct sequence, with single operation of AIRDOX Blow-Down Valve.

SEE THE NEWEST AND LATEST

AIRDOX CARDOX

PRODUCTION BOOSTERS

New AIRDOX Shooting Car
Used in the new AIRDOX Mobile Multiple Shooting System. Self-propelled, especially designed for mine use. Transports AIRDOX Tubes, high pressure hose, Sequence Valve, etc.

New AIRDOX Lightweight Tubes
Weigh only 27 pounds — easier and faster to handle.

New AIRDOX Automatic Discharge Heads
Operate at predetermined pressure over and over, without replacing shear strips.

New AIRDOX Sequence Valves
Now permit multiple shooting, with resulting savings in time and higher tonnage.

Also a complete line of CARDOX heat treated alloy steel augers, carbide tipped bits, all designed to give you lower cost per foot cut or drilled . . . Plus many others.

For any mine now using AIRDOX, this new Mobile Multiple Shooting System will substantially cut costs. For mines not yet using AIRDOX, it offers one more compelling reason for immediate investigation of AIRDOX savings . . . in easier loading and cleaning, greater safety, better rib and roof protection. Relatively small expenditure is involved. See how it works.

The shooter drives to the face in the new self-propelled AIRDOX Shooting Car. He places the AIRDOX Tubes in the lower row of holes and shoots them in proper sequence and in a single operation, in accordance with accepted safety standards. He moves the Tubes to the rows above and repeats until the entire face has been broken down.

Because the new lightweight AIRDOX Tubes also have *automatic discharge heads,* they can be used over and over again without the necessity of replacing disks, nails, shear strips, etc. Dead work is turned into productive time and higher tonnage.

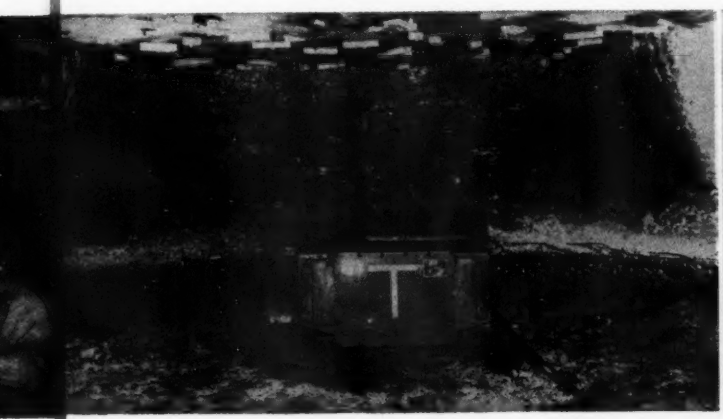
Each tube discharges at a pre-determined pressure. Sequence and high-speed shooting is controlled by an automatic Sequence Valve on the AIRDOX Car, which also carries the Tubes and high pressure hose to the face.

The AIRDOX Mobile Multiple Shooting System is a carefully researched and field-tested means to reduce face preparation time and costs. It retains all of the established AIRDOX advantages, may be used in seams of any thickness and offers particular advantages in thin seam operations.

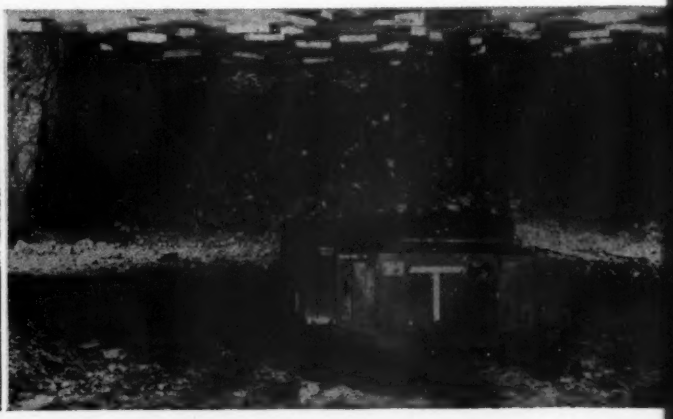
Your AIRDOX Engineer has details and operating savings realized by the AIRDOX Mobile Multiple Shooting System. Ask him for a full scale demonstration in your mine. Let the facts speak for themselves.

Write or phone today. This may be one of your most profitable steps in 1960!

Automatic, quick-sequence shooting of 4, 5 or more holes at a time reduces face preparation time and costs



4 Second row of holes is then shot. Note that Tubes are still in face. Automatic discharge heads in new AIRDOX Tubes enable Tubes to be reused without removing or replacing shear strips.



5 Here, the final row of holes has been shot. Note that coal rolls forward for easy loading. The shooter has made only one fourth as many trips to the face as formerly required.

You'll be seeing more and more new products and advances from

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AIRDOX PRODUCTS . . . Airdox and Cardox Non-Explosive Mining Methods . . . Complete Line of Carbide Tools . . . Augers, All Sizes . . . Auger Miners . . . Rotary Drills . . . Underground Mobile Equipment . . . Roof Bolting Machinery . . . Hydraulic Drills . . . Cardox Central Compression Systems for Air, Helium and Other Gases.

Here's proof Coromant rope-thread bits and steels SAVE TIME AND MONEY

"Up to double the footage between sharpenings!"
"Premature rod breakage is almost non-existent!"
"40% more usable life—more resharpenings!"
"Bit and rod life are well above average!"
"Uncouple by hand all the time!"
"More rigid—drills straighter holes!"*

**Names of men quoted available on request*

The comments above are actual quotes from project managers, job superintendents, and drill superintendents who have tested new Coromant rope-thread bits and steels. They've learned, on-the-job, the benefits they—and you—can expect!

For example: The new rope-thread (only two turns per inch) holds tight in use, yet permits hand uncoupling. Reports show that the time saved results in more footage drilled per shift. Bit footage is well above average too, with less loss of carbide inserts. Prime quality ore plus nickel-chrome alloy permits cold-rolling from billets for greater strength, life and rigidity. And only with Coromant rope-thread steels can you re-thread without heat treating, too. Do it yourself, or at any nearby machine shop.

Want to know more? There's no obligation on your part, but we'll be glad to help where we can. Just call your nearest Atlas Copco Office, or write to us at Dept. MCJ-7.

Atlas Copco

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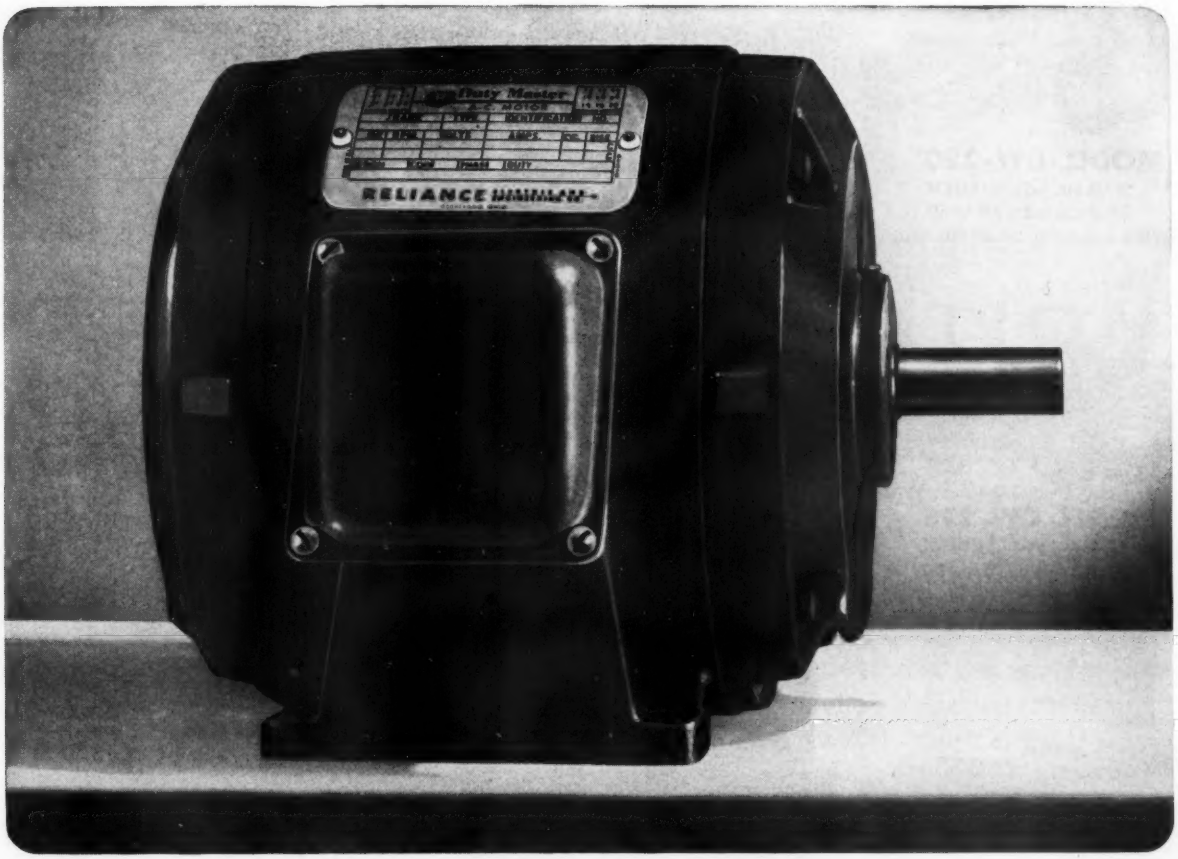

Duty Master

a brand new a-c. motor

Product of Reliance Electric and Engineering Company and its Master Electric Division, Duty Master's new design gives users better protection from the inside out, simplified lubrication, better response and improved all around performance. The Duty Master line, from protected-open, to totally-enclosed, explosion-proof, 1 to 250 hp., is ready for delivery *NOW*.

Duty Master's insulation, by means of a series of multiple dips and bakes in thermosetting varnish plus final protection in finishing enamel, makes it resistant to water, acid, dirt and other contaminating elements . . . adds years to motor life.

"Metermatic" lubrication regulates flow of grease to the bearing—provides automatic grease relief. No danger of over-or under-lubrication . . . no maintenance headaches.

Duty Master's low inertia rotor has faster response in starting, stopping and reversing. This plus better ventilation and increased accelerating torques, permits frequent starts and stops without over-heating.

Duty Master's new design proves conclusively that all a-c. motors are *not* alike . . . that this new motor gives users the best value in industry today.

Call your Reliance Sales Engineer or distributor—write for Bulletin No. B-2106. B-1696-A

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 92A, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
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Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

YARDS ON

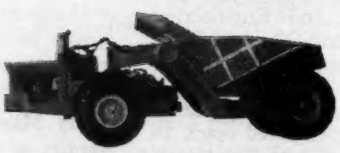
MODEL CW-220
20.0 cu. yds. STRUCK
27.0 cu. yds. HEAPED
INTERCHANGEABLE WITH MODEL CWD-221 REAR DUMP UNIT

MODEL CW-215
15.0 cu. yds. STRUCK
21.0 cu. yds. HEAPED
INTERCHANGEABLE WITH MODEL CWD-214 REAR DUMP UNIT

MODEL CW-27
7.0 cu. yds. STRUCK
10.0 cu. yds. HEAPED

MODEL CW-226
26.0 cu. yds. STRUCK
36.0 cu. yds. HEAPED

MODEL CW-320
20.0 cu. yds. STRUCK
27.0 cu. yds. HEAPED
INTERCHANGEABLE WITH MODEL CWD-221 REAR DUMP UNIT

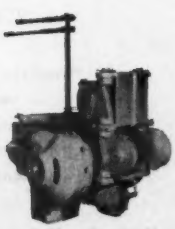


MODEL CWD-221
21.0 cu. yds. STRUCK
31.0 cu. yds. HEAPED
35-TON LOAD CAPACITY
INTERCHANGEABLE WITH MODELS:-CW-220

MODEL CWT-20
20.0 cu. yds. STRUCK
27.0 cu. yds. HEAPED

INTERCHANGEABLE WITH MODEL CW-320 SCRAPER UNIT

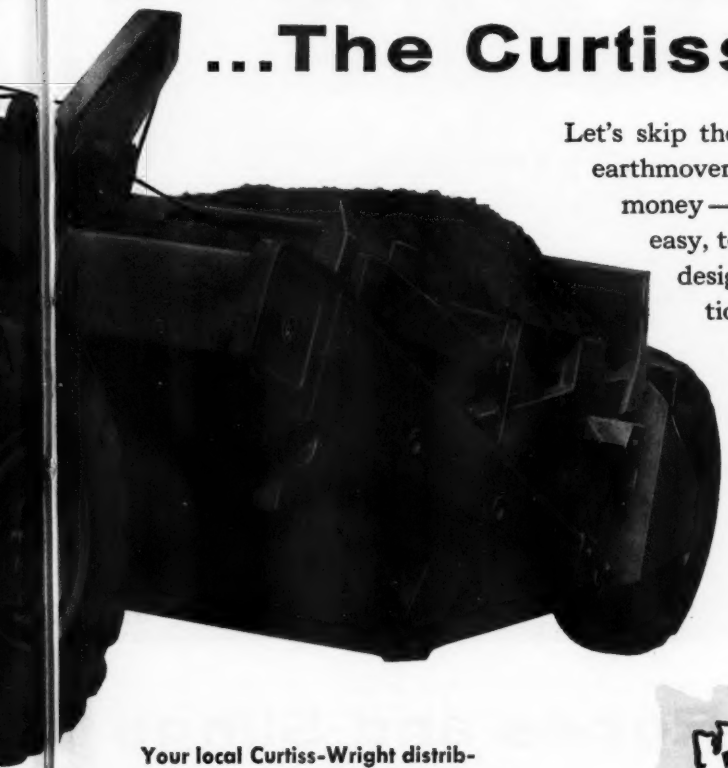
MODEL CWD-321
21.0 cu. yds. STRUCK
31.0 cu. yds. HEAPED
35-TON LOAD CAPACITY



CABLE CONTROLS
for standard tractors in every horsepower range

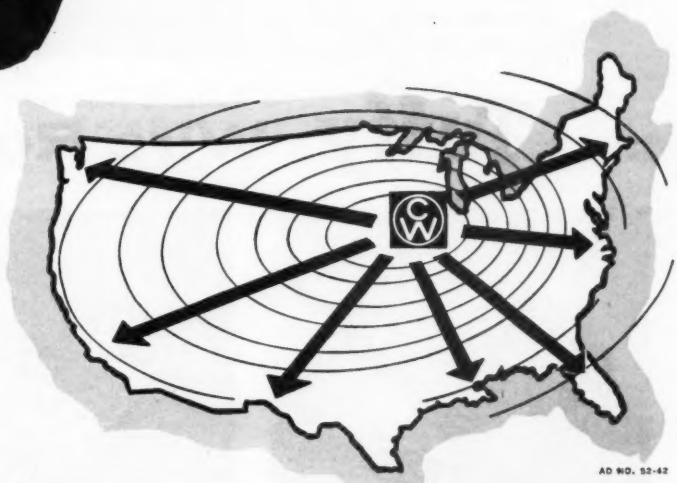
AHEAD

OPEN PIT EXCAVATION ...The Curtiss-Wright Line



Let's skip the details and get down to basic facts about earthmovers. If you move more dirt, you make more money — it's as simple as that . . . and just about as easy, too, with the modern Curtiss-Wright line. C-W design features for high performance, easy operation and low maintenance put you yards ahead in production — dollars ahead in profit on any earthmoving job. Call your Curtiss-Wright distributor for complete information and specs on the machine performance matched to your job requirements.

Your local Curtiss-Wright distributor is part of a nationwide sales, parts and service network devoted to making Curtiss-Wright users the most satisfied in the industry. You can depend on him for the most efficient, most cooperative service that it is possible to provide.



AD NO. 52-42

SOUTH BEND DIVISION, CURTISS-WRIGHT CORPORATION • SOUTH BEND, INDIANA

SOUTH BEND DIVISION
CURTISS-WRIGHT CORPORATION
SOUTH BEND, INDIANA

UNION

The *UNIQUE Wire Rope Organization

**Single in Kind or Excellence*

Customers can be credited for Union's outstanding position.

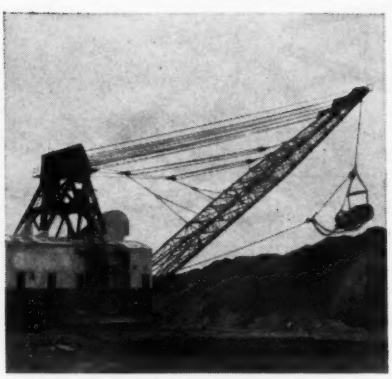
Why? Simply because in large numbers they accepted Union's standing invitation to share their wire rope and sling problems with Union's technical, research and engineering staff.

In meeting these challenges, Union has compiled an outstanding record in wire rope advancements. Some 1600 standard wire rope constructions are in day-to-day production under statistical quality controls which insure "the ultimate low cost rope." This means quality so good that it costs less in the long run.

In searching for better answers to wire rope and sling problems for customers, Union engineers developed the famous family of Tuffy wire ropes and slings.

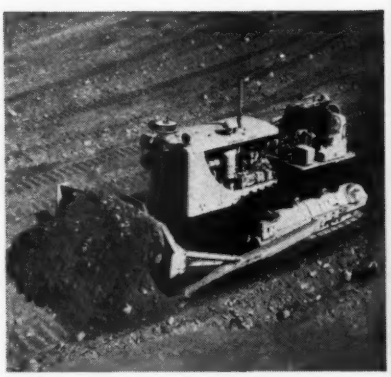
Each member of the Tuffy family is of a special construction tailored to one of the tougher wire rope jobs. In the Tuffy constructions there is balance—the right combination of strength, flexibility and resistance to wear for better performance and greater safety. When you say Tuffy, you specify the "Ultimate low cost" wire rope or sling.

Tuffy® Wire Ropes and Slings



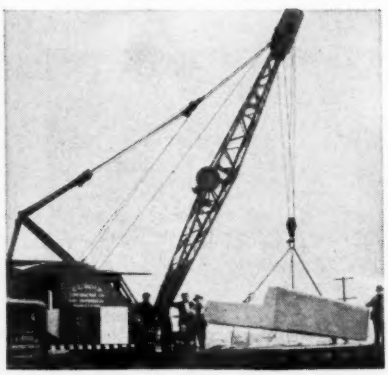
Tuffy Balanced Dragline Rope

Tuffy Balanced Scraper Rope



Tuffy Balanced Dozer Rope

Big Paul, The King of Spades, world's largest electric power shovel. In taking a 105 ton bite (2 rail carloads) it imposes a maximum bail pull upon the wire ropes of 550,000 lbs. One-half mile of wire rope is required in its operation by the Peabody Coal Company at its modern River King Mine, Freeburg, Ill.



Look Up Your Union Distributor In Phone Book Yellow Pages

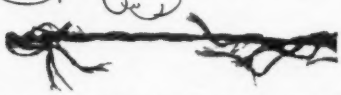
He's selected for his ability and willingness to supply you with the right Union standard or Tuffy wire rope construction, to check for proper installation and coach your operators in proper use to get the ultimate in service life. He is backed up by a nearby Union branch office and warehouse. If you would like to receive Union's Rope Dope Educational Bulletin, write Union Wire Rope Corporation, 2144 Manchester Ave., Kansas City 26, Mo.

Tuffy Wire Rope Tips on Safe Use of Wire Rope and Slings

On the Blink from a Kink

Mishandling of rope caused this open kink. Avoid kinks by proper winding on the drum. Never pull a loop smaller. Enlarge it, then straighten out the rope.

Overloaded - Soon Exploded



The rated capacity of a wire rope is based on breaking strength divided by the load factor for particular type of service. Grade of steel, type of construction and size of rope determine tensile strength. Unless rope is properly related to loads, costly and dangerous early failures are likely to occur.

Mangled in a Wedge Socket

Here's a result of improper socketing, caused by poorly designed or worn-out wedge socket. Can be costly and hazardous!

Victim of the "Bends"

Excessive bending of rope speeds up wear. General rule: use more flexible ropes as bending stresses increase (with decrease in tread diameter of sheave or drum). If sheaves are too small, early rope failure is certain.

Would you like a copy of a booklet in which more than a score of Tuffy Tips like those above are reproduced. If so, write Union Wire Rope Corporation, 2144 Manchester Ave., Kansas City 26, Missouri.

Tuffy Balanced Slings and Hoistlines

UNION Wire Rope

Subsidiary of ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company
Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Southwest Steel Products

1-C

a million yds. a month . . .

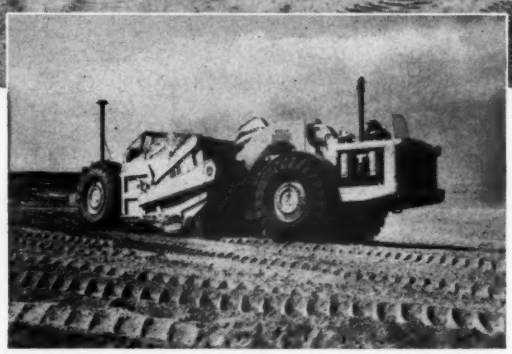
moved by Euclid "Twins"

At a mining operation in central Wyoming, a fleet of 18 Euclid scrapers is removing overburden from uranium ore at a rate of a million cu. yds. a month . . . nearly 21 million cu. yds. will be moved to uncover the ore body. It's a big, tough job to move that quantity of heavy sand over a mile of adverse grades up to 12%.

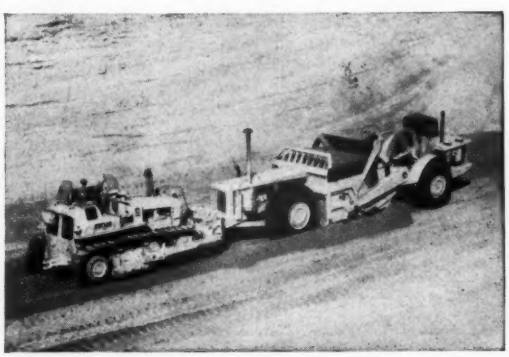
Maco Construction Co. of Rawlins, Wyoming, contractor on this stripping project, bought 12 Twin-Power "Euc" Scrapers of 24 yd. struck capacity to maintain high speed production. With two engines and all-wheel drive, these scrapers have the power and traction needed to move big loads up steep grades from pit to dumping area. Twin-Power is paying off in the big performance of Maco's five TC-12 Euclid crawler tractors, too—they're used for push loading this all-Euclid fleet of scrapers.

Wherever big tonnages must be moved on mine, quarry, industrial and heavy construction work, Euclid equipment provides more work-ability and better return on investment. The dealer in your area will be glad to supply facts and figures on Euclid rear-dump and bottom-dump haulers, scrapers, crawler tractors and front-end loaders.

EUCLID Division of General Motors, Cleveland 17, Ohio



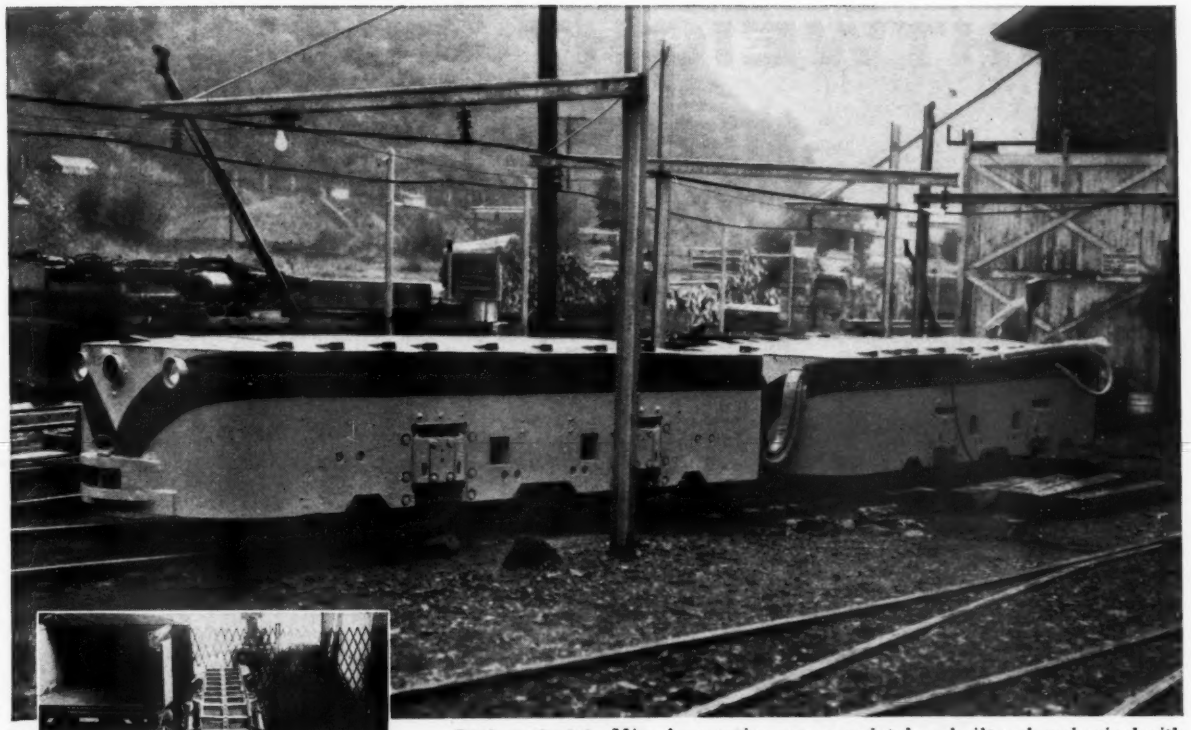
Big power and big capacity pay off in big production . . . Euclid TC-12 Crawler Tractor has 2 engines that deliver 425 net h.p. . . . "Twin" Scraper of 24 yd. struck capacity also has 2 engines (563 total h.p.) and all-wheel drive with separate Torqmatic Drives for each axle.



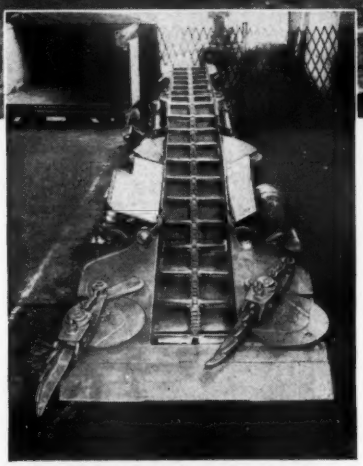
GM GENERAL MOTORS EUCLID

EUCLID EQUIPMENT

FOR MOVING EARTH, ROCK, COAL AND ORE



Back on the job. *Mine locomotive was completely rebuilt and modernized with contactor control, air brakes, air sanding and new bumpers.*



Not brand new but National new. *Rebuilt coal loader is one of many types of machines serviced by National's two coal field plants; in Bluefield, West Virginia, and Harlan, Kentucky.*

Get complete equipment rebuilding from National

The Specialists in electric coils/repair service

National offers not only electrical repairs but complete rebuilding service on all types of mining machines.

Often you'll find that National-serviced equipment performs better than new. The reason—equipment is not just restored but is modified to incorporate new developments and upgrade original performance. Motor windings, for instance, have the very latest and best grade insulation tailored by National to your requirements. The latest improvements in control and mechanical systems bring your equipment up-to-date at the time of complete overhaul.

National completely dismantles, inspects, rebuilds and tests. The work is done by specialists. For fast service, contact our nearest plant or your National field engineer.

National Electric Coil

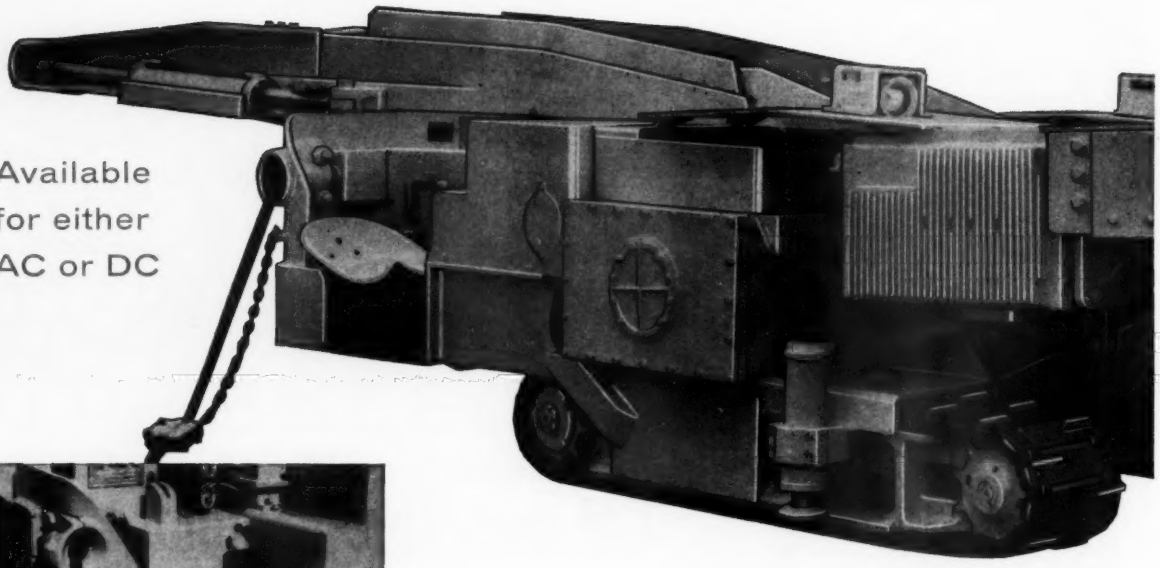
McGRAW EDISON

DIVISION OF McGRAW-EDISON COMPANY

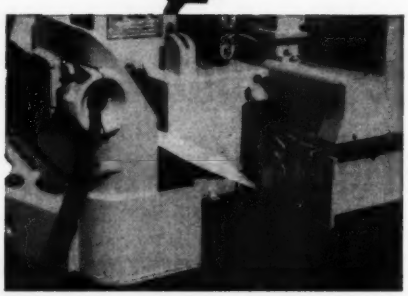
COLUMBUS 16, OHIO

ELECTRICAL ENGINEERS•MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS•REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

LIGHTWEIGHT COST *plus* HEAVYWEIGHT *equals* PRODUCTION



Available for either AC or DC



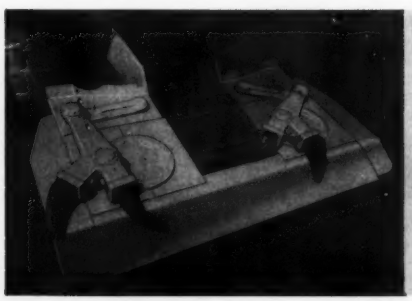
OPERATOR'S PLATFORM

Compact and convenient hydraulic and electrical controls are within easy reach of the operator. Throttle valve precisely controls the speed of all hydraulic operations as well as providing "deadman" control.

16″ WIDE CRAWLER

The new crawler with heavy-duty gearing can operate the miner on steep grades and also float on soft bottom.

Less than 25 P.S.I. ground pressure.



GATHERING HEAD

The exclusive "dual gathering arms" provide maximum reach and much better flow to the conveyor.

PERFORMANCE PUNCH

Lee-Norse CM38 and CM48 MINERS

29 TONS with power-smooth cutter-action that cuts 42" to 120" seams and gathers loads as fast as they are cut

CUTTING HEADS

New "Rap-Lok*" Cutter Bits, spaced evenly around cutter rim, provides smooth, vibrationless performance. Extremely quick "bit change"—no set screws—long bit life.

*Trade Mark of The Cincinnati Mine Machinery Co.

Lee-Norse Company

CHARLEROI, PENNA.

Specialists in Coal Mining Equipment

Coal high or low?... Lee-Norse MINERS keep production on the go!

USS Tiger Brand hoist ropes

last over 1800 hours

on 25-yard dragline

This big dragline works around the clock—three shifts a day—at the Harmattan Mine of Fairview Collieries Corporation, Danville, Illinois. The twin hoist ropes hardly have a chance to cool off but they last over 1800 hours in this rugged service.

The USS Tiger Brand hoist ropes are two inches in diameter and 450 feet long. They are made of tough Monitor steel which has a reputation for long service on jobs like this.

The upper boom supports are also Tiger Brand—six two-inch diameter galvanized boom support strands 118 feet long. These are noted for their strength and resistance to vibration fatigue. Most of the largest shovels in the country are equipped with USS Tiger Brand Boom Support assemblies because of their reputation for safety and long service.

Why USS Tiger Brand is your best buy.

Tiger Brand Wire Rope is designed by one of the industry's most capable staffs of wire rope engineers. It is made by a company that maintains the most complete research and manufacturing facilities in the steel industry. When you buy Tiger Brand you get the right rope for the job. And your installation is no further away than a phone call from experienced American Steel & Wire field service representatives.

You can get Tiger Brand Wire Ropes for any type of mining service. For information write American Steel & Wire, Dept. 0110, 614 Superior Ave., N.W., Cleveland 13, Ohio.

USS and Tiger Brand are registered trademarks

USS Tiger Brand hoist ropes and boom supports help keep this 25-yard dragline on the job around the clock.

Double drum shows 2-in. Tiger Brand hoist ropes designed for strength and flexibility.

American Steel & Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco
Tennessee Coal & Iron, Fairfield, Alabama
United States Steel Export Company

THE RIGHT BIT.. FOR YOUR JOB!

And it's there ON TIME!

With plants located throughout the world, Christensen meets your drilling requirements with the right bit, on the job, in time —

RESETTING — Your used diamonds can be reset in the same bit style or type. Your bit style can be changed to meet any new drilling requirement. You are billed only for the new diamonds, plus a nominal fee for setting. Regardless of type or manufacture of core barrel presently in use, we can complete your order of diamond bits or shells to fit its specifications.

TIME — Your new style or reset bit can be shipped within five working days after your order has been received.

CORE BARRELS — For standard equipment listed in our catalog SD 507, a maximum of two days is required before shipment, and frequently shipment is made the same day your order is received. Custom designed core barrels manufactured to any size and specification — let us quote you price and delivery.

MISCELLANEOUS DRILLING SUPPLIES — As a convenience to our customers, drill rod, casing, handling and fishing tools are also available.

The combination of Christensen's experience and unequaled service assures you of "less cost per foot", regardless of job location.

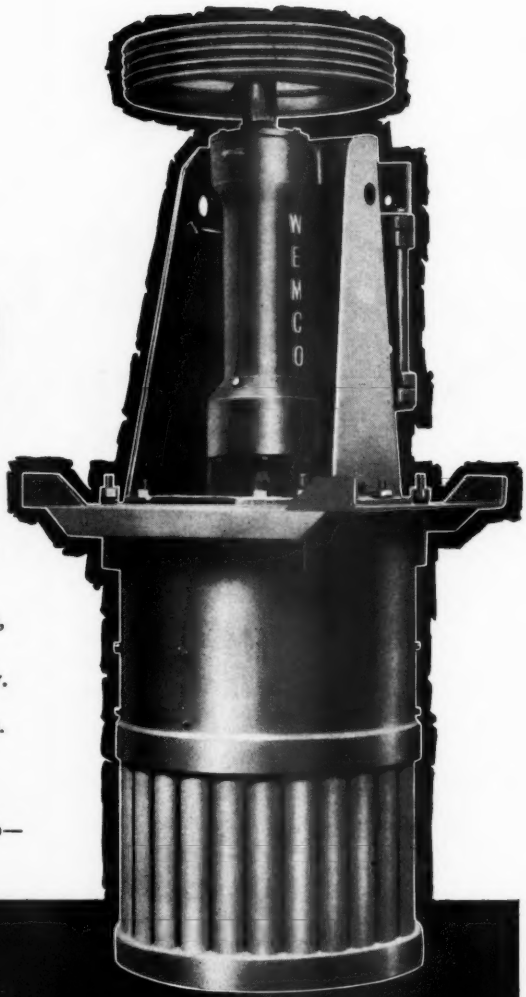
Call Christensen today!

Diamonds Mean, "Less cost per foot."

CHRISTENSEN DIAMOND PRODUCTS

1937 SOUTH SECOND WEST • SALT LAKE CITY, UTAH

THIS DECISION WILL PAY BONUS PROFITS OF MORE THAN $6,500 EVERY DAY!



This order and installation of Wemco-Fagergren Flotation Machines by a leading coal producer will result in additional profits of over *$6500 per working day*— and for surprisingly low capital investment. Cost of the total plant addition, including the flotation cells, will be offset in less than four months.

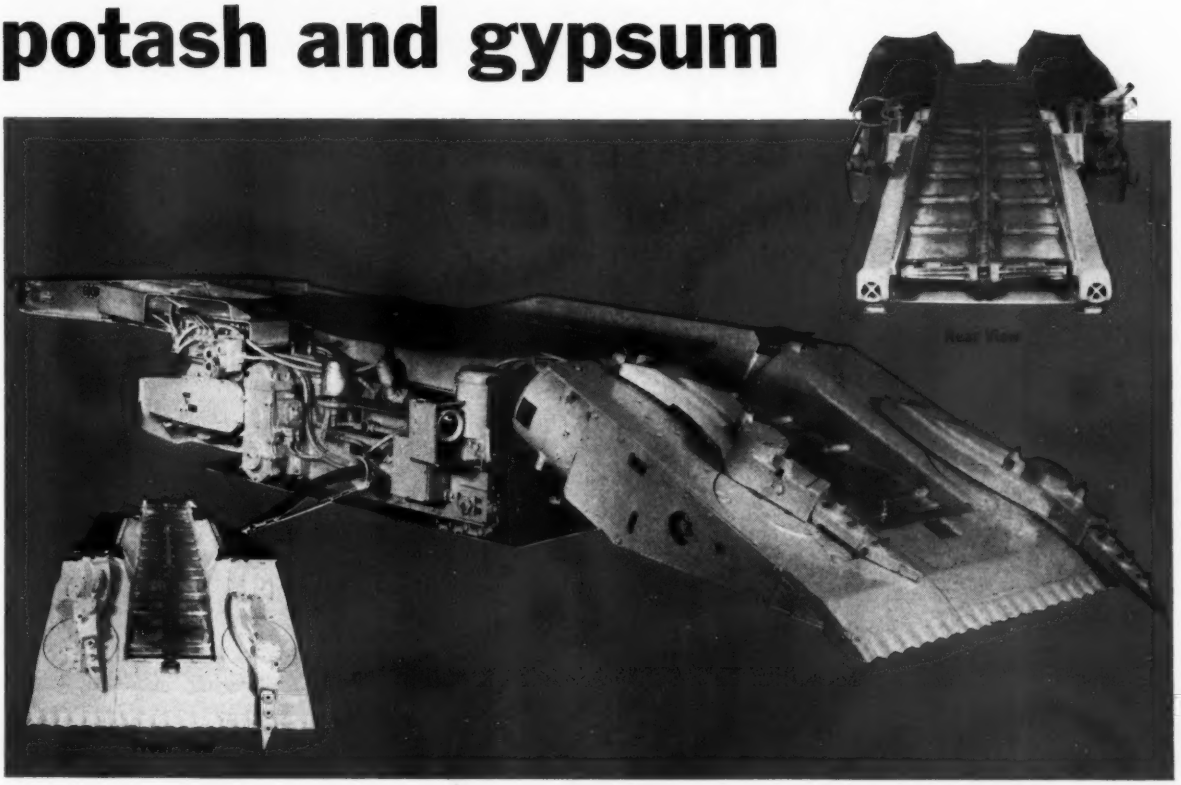
This is another example of how Fags go to work—profitably. Recovery is consistently higher; floor space, maintenance and operating labor, reagent and other requirements are less.

The Wemco-Fagergren record of profit-producing installations tells the story of sound experience. The men of Wemco will be glad to furnish all the facts and discuss why Wemco-Fagergren Flotation will do a better job—where flotation has a place.

WEMCO®

a division of
Western Machinery Company, 650 Fifth St., San Francisco, Calif.
and throughout the world

For loading in intermediate and high seams of coal, potash and gypsum



new Goodman 967 loader

This newest Goodman loader with 38″ basic body height and a load line height of 24″, is conservatively rated at 15 to 20 tons per minute. It's the answer to high capacity loading in intermediate and higher seams because of these built-in advantages:

30″ Wide Conveyor with ample depth at all points to contain any surge load. A rugged 2¼″ pitch chain keeps material moving.

12″ Wide Treads each with 4½′ of ground contact plus a total weight of 14 tons provide a stability for the heaviest kind of loading. 6″ roadway clearance assures freedom of movement on all types of bottom.

The above advantages are combined with these additional features . . . 7′6″ clean-up width . . . 55 gathering arm strokes per minute . . . adequately powered with 4 motors, each 21 hp. DC, 26 hp. AC . . . quick-acting hydraulic controls . . . extra strong construction throughout.

For the full story of the new 967 loader and of shuttle cars with the speed and capacity to keep it working, contact your Goodman sales engineer.

GOODMAN
MANUFACTURING COMPANY
Halsted Street and 48th Place, Chicago 9, Illinois

CUTTING MACHINES • CONVEYORS • LOADERS
SHUTTLE CARS • LOCOMOTIVES • CONTINUOUS MINERS

Use Genuine Goodman Replacement Parts

ANOTHER **ACME** DOLLAR SAVER

the ***NEW***

JUMBO DRIFTER

that keeps pace with
the rest of your equipment

ACME MACHINERY COMPANY

This new ACME Jumbo Drifter is a self-propelled drifter type rig for drilling rock headings or brushing top with greater speed, less effort and at lower cost.

It is equipped with four-wheel tractor type drive — either electric or air motor. Available with manual or power arm movement. Power-screw type feed or chain feed is optional, in varying lengths with 3″ or 3½″ bore drifters. Boom centers are rigged to your specific conditions. Height and grade requirements can be maintained with advance of section.

Acme builds a drill rig to suit YOUR mining conditions.

ACME MACHINERY COMPANY

HUNTINGTON, WEST VIRGINIA

WAREHOUSE AND SALES OFFICE
MORGANTOWN, W. VA.

• REPRESENTATIVES IN PRINCIPAL MINING AREAS

fast, firm support for cable or pipe...

O-B Roof Plate Hooks!

Here's a new type of support for cable or pipe up to 2½ inches in diameter!

No slots, wedges, or parts to fool with or lose. Just a simple, inexpensive, practically indestructible malleable iron hook that you drive between roof plate and roof with a few hammer blows.

No sharp edges, no wobble, no accidental pull-out. Tapered support arm is serrated on top and bottom surfaces so it drives in easily and stays put when pushed or pulled from any direction. When the job is done, hammer it out from the opposite direction and use it again—and again. The high-quality malleable iron takes plenty of pounding without cracking or breaking.

Get your cable or pipe "out from under" foot or wheel this safe, easy, economical way.

Order Catalog Number 22753 today!

OHIO BRASS COMPANY • MANSFIELD, OHIO
Canadian Ohio Brass Company, Ltd., Niagara Falls, Ontario

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HOLAN

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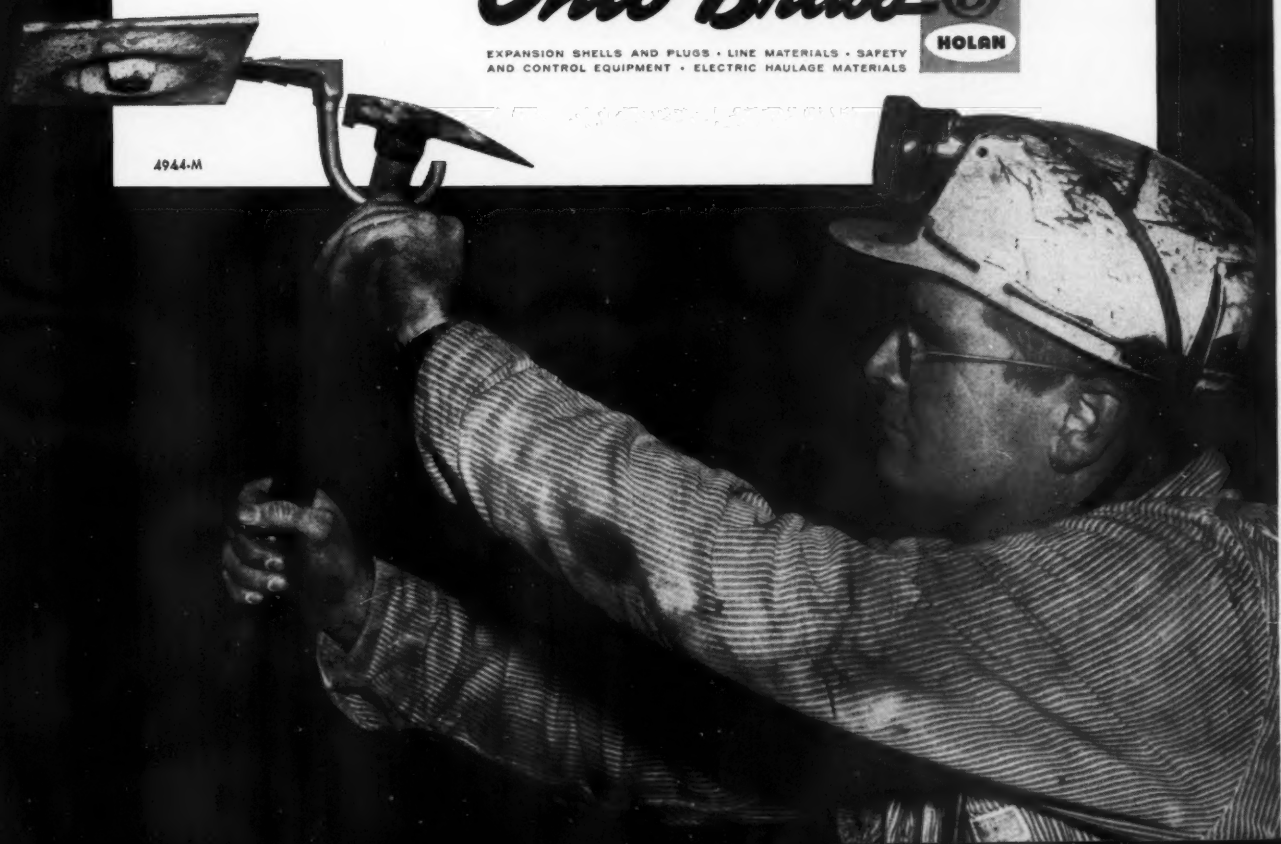

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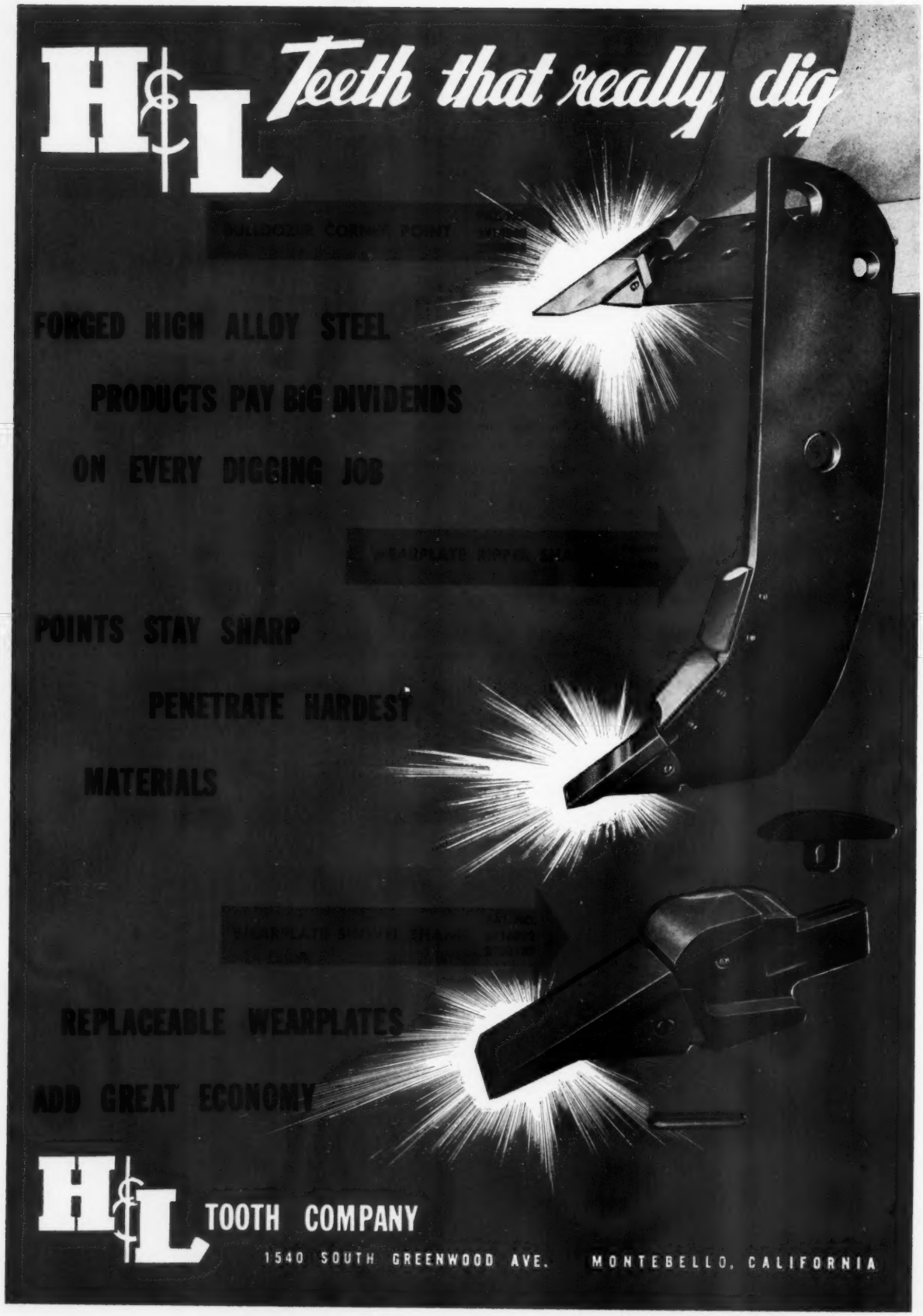

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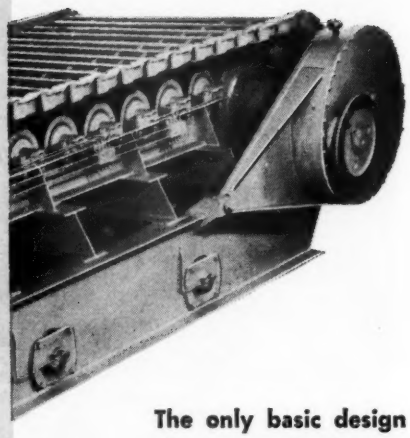

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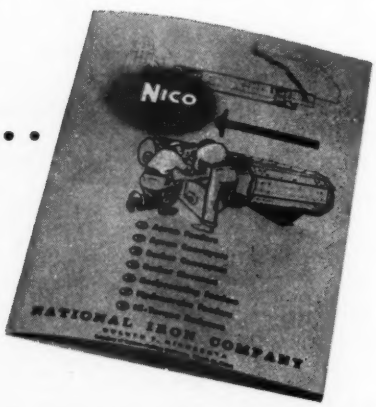

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EDITORIAL

ROBERT W. VAN EVERA, Editor

FEBRUARY 1960

Taking Stock of the Year Just Ended

This issue of *Mining Congress Journal* summarizes events in 1959 in the various branches of the mining industry and reviews the year's progress in improving the skills, methods and machines used in mineral production. In the over-all economic picture, the articles comprising this review tend to confirm various analyses and forecasts which have already been published concerning the status of American industry generally.

The steel strike was the dominant single factor influencing the fortunes of the mining business last year —from early in the year when a disproportionate inventory build-up was taking place in anticipation of the strike, through the 116-day period starting July 15 when the bulk of the steel producing facilities were shut down. Thus, 1959 was not a normal year, but according to our reviewers the long-range trend points to continued growth. The high level needs of our growing economy plus considerable "pent-up" demand for minerals indicate that 1960 will be an extremely active year in mining.

As you read the articles in this issue you will find that although generally following the national economic pattern, mining is not an industry of conformity, but rather of strong individualism. Each branch has its own specific problems calling for special means of solution.

In 1959 many significant problems were solved—or partially solved—and, of course, new ones arose. Certain problems, unfortunately, became more intense. Of these, the most serious stem from increased labor costs. American mineral products have for years found it increasingly difficult to compete with foreign minerals produced with cheap labor. As domestic wages rise, our competitive position obviously gets weaker—not only in foreign markets but at home as well.

One the other side of the coin, American miners in many fields appear confident of retaining and expanding markets through superior "know how." Again, the articles in this review clearly indicate that research, application of basic science, and more streamlining of production facilities are paying off. Although few spectacular "breakthroughs" occurred in the mineral sciences, steady progress is apparent, as shown in the reviews of Geology, Mineral Dressing, Coal Research, Mechanical Mining, Safety, and Underground and Open Cut Mining of Coal, Metal Ores and Industrial Minerals.

The industry may well take pride in its record of advancing the technology of finding more efficient ways of extracting mineral values from the earth.

"Loopholes" in the Tax Law

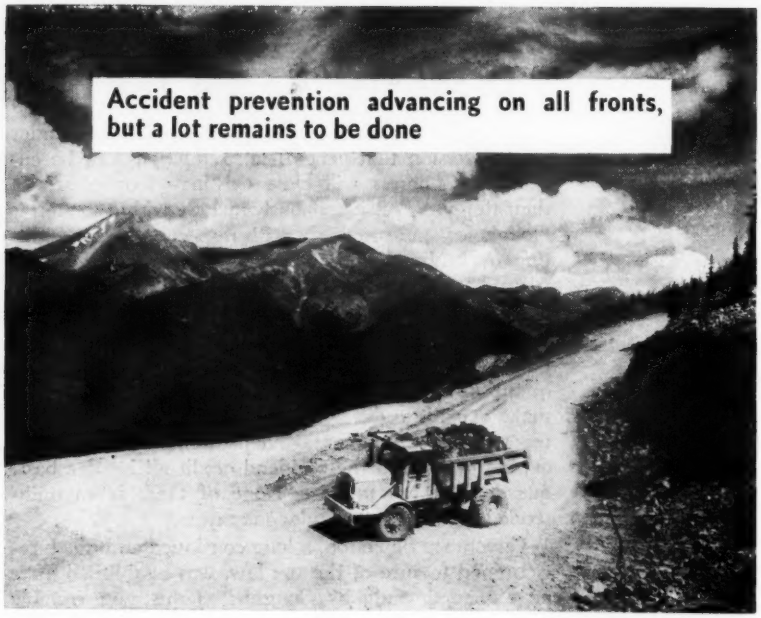
Too many members of the general public are under the impression that general tax reductions can be enacted if Congress will close existing "loopholes." In their thinking they erroneously include within the terms "loopholes" tax provisions with respect to income splitting by husband and wife, percentage depletion, the treatment of capital gains, and dividend credit.

In a recent study entitled "Revising the Rate and Bracket Structure," Tax Foundation, Inc., pointed out that true loopholes—unintended benefits—are "not quantitatively significant" and closing them would make very little difference to the tax base. Further, it was pointed out, percentage depletion, income splitting, capital gains, and the dividend credit all involve basic questions of tax policy—"None of them is an unintended benefit to particular taxpayers."

Percentage depletion, a long continued and much reexamined feature of the tax law, was established after an extended study by Congress as the most suitable method of dealing with special conditions in the mineral industry, and as a means of stimulating investment in the discovery and production of minerals. In 1952 the President's Materials Policy Committee recommended that continuation of percentage depletion and some liberalization of tax treatment to encourage the development of minerals.

The latest examination of percentage depletion occurred in the recently-concluded Ways and Means Committee study on possibilities of "broadening the tax base." In the course of that hearing, able witnesses for the minerals industry pointed out that percentage depletion is essential if our Nation is to be assured of a supply of minerals essential to the maintenance of a dynamic and expanding economy. The search for and production of mineral resources is an extremely speculative business, with inherent risks far greater than those found in other private enterprise, and an adequate depletion allowance is a far better method of assuring supply than any type of subsidy would be. In addition, special tax treatment is required by considerations of fairness, because the producer of a wasting asset is receiving, in substantial part, return of capital instead of ordinary income as the term is used in a manufacturing, wholesale, or retail business.

During the hearings on "broadening the tax base," the Ways and Means Committee heard from opponents of percentage depletion, whose principal objection seemed to be that perhaps the cost to the Nation was unnecessarily high. However, the mining industry and oil industry witnesses again demonstrated that the Nation has received benefits from percentage depletion far in excess of the cost through availability of minerals, at low cost, in peace and in war, with consequent high standard of living and the ability to repel aggressors. In fact, the results of the panel discussion were aptly summed up by Congressman Noah M. Mason (Rep., Ill.), who said: "The problem before this Committee is the cost of depletion versus the benefits of depletion. A great majority of the panelists seem to feel that the benefits outweigh the costs—and I agree."



Progress in Mine Safety

By R. R. WILLIAMS, JR.
Manager of Mines
The Colorado Fuel and Iron Corp.

THE U. S. Bureau of Mines reports that 1959 saw the lowest number of fatalities on record since complete coal mine fatalities statistics have been published by the Bureau. Preliminary reports indicate 290 fatalities which occurred at frequency rates of 0.68 per million tons of coal produced and 0.99 per million man-hours of exposure.

The bituminous coal and lignite industry reported 244 fatalities at frequency rates of 0.60 per million tons of coal produced and 0.92 per million man-hours exposure. Forty six fatalities were reported at anthracite mines for the year at frequency rates of 2.35 per million tons of coal produced and 1.64 per million man-hours of work. Injury experience of the mining industry for the last six years is set forth in Table I.

Falls of roof, rib and face continue to be the leading cause of fatalities in underground coal mines, with 152 coal miners dying from this cause during the year.

TABLE I. INJURY EXPERIENCE—MINES—1954-1958 INCLUSIVE

	Number of Injuries		Frequency Rates Per Million Man-Hours	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Bituminous Coal Mines				
1954	334	14,746	0.99	43.66
1955	360	15,966	0.96	42.76
1956	392	16,486	1.02	42.99
1957	427	15,915	1.17	43.74
1958 (1)	324	12,230	1.16	43.87
1959 (1)	244	N.A.	0.92	N.A.
Anthracite Coal Mines				
1954	62	2,972	1.23	59.18
1955	60	2,919	1.30	63.46
1956	56	3,330	1.12	66.31
1957	51	2,877	1.15	64.93
1958	32	2,124	0.90	59.88
1959 (1)	46	N.A.	1.64	N.A.
Total Coal Mines				
1954	396	17,718	1.02	45.67
1955	420	18,885	1.00	45.03
1956	448	19,816	1.03	45.69
1957	478	18,792	1.17	46.04
1958	356	14,354	1.13	45.68
1959 (1)	290	N.A.	0.99	N.A.
Metal Mines				
1954	86	4,994	0.66	38.27
1955	79	5,837	0.58	42.62
1956 (2)	89	5,475	0.62	37.91
1957	71	4,554	0.50	32.03
1958 (3)	54	3,116	0.57	32.70
Non-Metal Mines (Except Stone Quarries)				
1954	9	956	0.30	32.34
1955	19	1,156	0.61	37.18
1956	17	1,036	0.50	30.50
1957	9	1,112	0.24	29.36
1958 (3)	14	909	0.39	25.30

Source of material: U. S. Bureau of Mines
(1) Data are preliminary.
(2) Revised.
(3) Preliminary; compiled from reports received in the Washington Office by June 15, 1959.
N.A. Not available

A Coloradan by birth R. R. Williams, Jr., has been associated with the Colorado Fuel & Iron Corp. since 1929. Starting as a junior mining engineer, he was employed in the blast furnace department from 1930 until 1953 when he went to the mining department as assistant manager. Since 1954 he has been manager of mines.

A metallurgical engineer graduate of the Colorado School of Mines, "Bob" Williams was awarded that school's Distinguished Achievement Medal on May 22, 1959.

Two major disasters occurred during 1959 in the nation's coal industry. Twelve men lost their lives in the flooding of an anthracite mine and nine men were killed in a bituminous mine gas explosion in Tennessee.

Recent Developments For Improved Safety at Coal Mines

Face ventilation and dust control with continuous miners. The ventilation group of the U. S. Bureau of Mines has conducted extensive experiments with a combination of line-brattice and auxiliary diffuser in ventilation of continuous miner faces. Experiments have indicated the feasibility of a combination brattice-diffuser being most effective when operated with the diffuser discharging through an elbow directly across the face; and further indicate that this method, with the proper ratio of line brattice discharge and diffuser capacity, may be used to further reduce methane concentrations and control higher liberations of methane.

Auxiliary fans. The Bureau of Mines announced a change in regulations on the use of auxiliary fans in conjunction with continuous mining machines and other types of face equipment, including conventional loading and cutting machines. The revision modifies the required volume of air reaching the auxiliary fan, along with a set of special precautions to assure the safest possible use of auxiliary fans, whether blowing or exhausting, with various types of face equipment. Previous restrictions relating to permissibility and permits for fan use remain unchanged.

Methane monitoring system for continuous miners. Progress so far by a number of manufacturers in conjunction with the U.S.B.M. indicates that there will be available before long one or more permissible methane monitoring systems whereby the methane content of the mine air will be indicated automatically at all times, and when the methane content of the atmosphere reaches a predetermined concentration the power will be cut off automatically from each machine in the affected area. Such a mechanism should be so devised that its setting could not be altered or changed in the mine.

Fire-resistant hydraulic fluid. A cooperative program between the Bureau of Mines and oil suppliers has resulted in the development of a water-in-oil emulsion for hydraulic use in mines, athough its preparation and use pose economic and operating problems not encountered with the conventional hydraulic oil. However, experiments of the fire-resistant fluid so far have been encouraging and will mean improved safety once it is developed to compete economically with the standard hydraulic fluid.

Protective equipment of this iron ore miner includes hard hat, goggles, gloves, spats, leggings, and hard-toed shoes

Experimental work in roof cementation. The Bureau of Mines, in cooperation with mine operators and equipment manufacturers, is continuing its experimental work in roof cementation by various methods, but so far roof gluing, or cementation, as a form of roof support has not been developed to the extent that it can be recommended as a replacement for the conventional roof supports. If and when this comes to pass, it will be a boon to the coal industry.

Electronic sentry. One of the mining equipment manufacturers is now marketing an electronic sentry or detection device for mounting on any d-c mobile mining machine that receives its power through a portable cable. It is claimed this sentry will provide complete protection against the electrical faults and occurrences expected in operation. This is accomplished without a grounding conductor in the trailing cable and includes the complete machine and cable. The device cuts off the power from the machine and its trailing cable in the event of a ground fault, short circuit, or break in the cable, and prevents energizing the equipment so long as the trouble exists.

Mining shield offers possibilities. Recently a mining shield, developed by the U. S. Bureau of Mines, which was designed for roof protection of men and mining equipment in the face region where the large majority of injuries from roof falls occur, has been put on the market. Hydraulic rams telescope and steer the unit forward as the face advances and makes possible a greater utilization of continous mining machines. The flexibility of the design of the shield may make possible its widespread use at the working faces in the industry's underground mines.

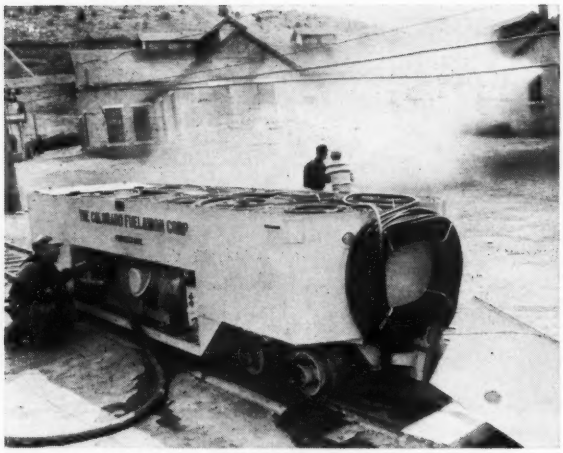
There is also some possibility of developing an electronic roof testing device that will forecast falls and bumps.

Another device now being considered involves remote control whereby the machine operator would be 50 ft outby the machine when it is operating at the face.

Plastic conveyor belts and plastic covered trailing cables. Experiments are being conducted in a number of underground mines with plastic belts and plastic-covered trailing cables mainly to minimize fire hazards. Certain types of plastic belt appear to indicate, after considerable usage, that they will stand the abuse and be more economical than rubber belt, in addition to meeting the primary purpose, that of being safer from a fire hazard standpoint than is conventional belt.

The transition to plastic trailing cables is also underway at certain

Roof-bolted entry with supported air and water lines. Falls of roof, rib, and face continue to be the leading cause of fatalities in underground coal mines



New high pressure fire truck with combination fog or straight stream nozzle undergoing tests before being taken underground

coal mining properties. With the severe operational abuse involved, the cable is a possible source of fire. Consequently, it is important that cables on portable mining equipment represent the absolute maximum in both safety and serviceability. It can be stated that plastic mining cables are apparently making a definite contribution toward greater safety and longer, safe service life. It is anticipated that current development programs will lead to still greater improvements over the next few years.

Metatarsal guard safety shoe. This new type of safety shoe is basically the same safety shoe now widely used by mine workers, only with a tough resilient guard over all the toes and instep. It provides complete protection for the entire foot, covering the areas formerly left relatively unprotected by the hard-toed shoe against falling or rolling objects.

Legislation regarding Federal Coal Mine Safety Act. There is an amendment to the Federal Coal Mine Safety Act before the U. S. Congress to remove certain exemptions with respect to coal mines employing no more than 14 individuals. This will be up for consideration during the current session of Congress. The Amendment, if passed, will change appeal procedures in the case of the small mine operators and set up additional appeal procedures for mine operators having less than eight men.

Accident-scene photographs. The Colorado Fuel and Iron Corp. has adopted the accident-scene photograph method of accident investigation. Photographs of reconstructed accidents, along with photographs of preventive measures, are used in monthly safety bulletins and displayed on bulletin boards and other prominent places on the mining premises. The result of this approach is a significant decrease in frequency and severity rates, mainly because of better communications between company and employes.

Roof fall safety campaign. The National Roof Fall Safety Campaign began July 1, 1957, and ended June 30, 1958. Approximately 1200 coal mines enrolled, and 509 fewer roof fall accidents were reported during the comparable base period, or a reduction of 38 percent in the number of injuries previously reported. Certificates of Achievement were awarded to 182 mines by the National Safety Council, and several thousand Certificates of Commendation were awarded to supervisors and union safety committee members, along with Certificates of Meritorious Service to local unions who actively participated at mines which received Certificates of Achievement.

A new roof fall campaign began January 1, 1960, and will terminate December 31, 1960. This campaign is sponsored by Federal and State agencies, the United Mine Workers of America, coal associations, safety organizations, and others, and awards will be given by the National Safety Council to mines, supervisors, local unions, and union safety committeemen who achieve the campaign goal and who meet the other necessary requirements. Materials intended to develop and maintain the interest of employer and employe are available from the Council. Sponsors of the campaign are urging all underground coal mines of the United States to participate in this safety campaign. The goal is a reduction of 50 percent or better in frequency rate of injuries from roof falls.

General

Mouth-to-mouth resuscitation. It appears to be almost the unanimous opinion that the mouth-to-mouth technique is the most practical method of artificial respiration. This method is endorsed by various responsible agencies without going into the relative values of various types of adjunct equipment. They are concerned primarily with the situation in which there is urgent need to provide artificial respiration by the first person on the scene.

Off-the-job safety. The planning of leadership in the mining industry has brought steadily declining death and injury rates from occupational accidents. At the same time, there have been no comparable reductions in off-the-job death and injury rates. The typical mining industry employe is much safer at work than he is off the job, probably as much as 15 to 20 times safer at work in some cases. While off-the-job safety is not a direct responsibility of management, it can be stated that industry's safety and accident program activities will be reflected in public or off-the-job safety. Many mining companies have started off-the-job safety programs in

Specifications governing the health and safety of the employes, both underground and surface, were part of the basic design of this captive coal mine of the Colorado Fuel & Iron Corp.

cooperation with the National Safety Council.

1959 national first-aid and mine rescue contest. This contest was held in Buffalo, N. Y., on October 5, 6, and 7, 1959. Forty-three teams were entered in the first-aid contest, nine in mine rescue, and six in the combination first-aid and mine rescue. There were six winning teams in the first-aid classification, four in the mine rescue group, and two in the combination first-aid and mine rescue entrants. Trophies were awarded to the winning teams by U. S. Bureau of Mines, Joseph A. Holmes Safety Association, United Mine Workers of America, National Coal Association, and Mine Safety Appliances Co.

Radiation Protection Laws at Uranium Processing Plants

During recent years there has been a definite trend toward the development of strong radiation protection laws and codes, particularly at the state level. Some states have approved detailed performance codes and some others have adopted some radiation protection rules. It is felt that the states and the Atomic Energy Commission can regulate simultaneously in this field and that industry will learn to deal effectively with this hazard.

First-Aid and Accident Prevention Training

Experience of the U. S. Bureau of Mines and the mining industry has proven that first-aid and accident prevention training has been worthwhile.

Since 1952, the peak year in first-aid training was in 1954 when 36,649 persons were trained in the mineral industries, including coal mining, metal and non-metal mining, petroleum, metallurgical, tunnel work, cement plants, and so forth.

Since 1952, the peak year in accident prevention training was in 1955 when 31,897 persons were trained in the coal mining industry, including the courses for supervisors and workmen, on-the-job training, and the new course "The Fundamentals of Accident Prevention."

Table II gives the number of persons trained in first-aid and accident prevention for the past seven years and ten months. The summary of persons trained in accident prevention under the heading of "Metal and Non-Metal Mines" also includes quarries, tunnel work, non-ferrous metal processing plants, cement plants, and so forth.

The Joseph A. Holmes Safety Association

The Joseph A. Holmes Safety Association was founded in 1916 by several leading national organizations representing mining, metallurgy, and allied industries to commemorate the efforts of Joseph Austin Holmes, the first director of the U. S. Bureau of Mines, to reduce accidents and poor health in mining and allied industries and promote the doctrines of safety and conservation of life in those industries. It is the aim of the association to bring safety in the mining and allied industries before the public and to stimulate the safety movement by giving Certificates of Honor for outstanding achievements in safety and medals of honor for personal heroism or distinguished service in the saving of life in any branch of mining, quarrying, and mineral extractive industries.

Holmes Safety Association is a separate and independent organization entitled to select six representatives to serve on the Board of Directors of the Joseph A. Holmes Safety Association. The chief function of the safety association is the establishment of its chapters in the mining, mineral, and extracting industries, to forward health and safety of the workers in the mineral industries, and all the residents of the communities in which the workers live. The Holmes Safety Association was organized in 1926 and at the present time has 21 councils, which in turn are divided into 271 chapters. Seven hundred twenty-seven chapter meetings were held during the first ten months of 1959, with a total attendance of 33,085 persons.

At the annual meeting of the Joseph A. Holmes Safety Association on April 21, 1959, the delegates voted to make the folowing awards:

10 Medals of Honor
1 Certificate of Honor
1 Group Certificate of Honor to 5 men
469 Certificates of Honor for safety records.

The distribution of these awards is detailed below.

Awards for Safety Accomplishments

Coal mines and mining companies	45
Metal mines and mining companies	86
Petroleum plants and companies	70
Quarries, non-metallic mines and companies	32
Individuals (40 years or more without lost-time accident)	183
Officials	52
Miscellaneous	1
Total	469

Geographical Locations of Recipients of Certificates of Honor (Mississippi River dividing line)

	East		West		Other	
Coal mines and mining companies	41	91.11%	4	8.89%		
Metal mines and mining companies	65	75.58%	21	24.42%		
Petroleum plants and companies	5	7.14%	63	90.00%	2	2.86%
Quarries, non-metallic mines & companies	21	65.63%	11	34.37%		
Individuals	152	83.06%	31	16.94%		
Officials	41	78.85%	11	21.15%		
Miscellaneous					1	

In addition to the above, 11 Medal of Honor Certificates and two Certificates of Honor were granted.

It must be recognized that the mining industry has made great strides forward in making its mines and industrial plants safe places in which to work. We know that the operating personnel have become acutely safety-conscious and realize that they cannot afford to function without a sound accident prevention program. The lack of a good safety attitude can be dangerous to management and labor alike. It is the mutual responsibility of mine officials and employes to see that an accident prevention program is kept alive and interesting continuously, and that this responsibility never ends.

TABLE II. FIGURES ON TRAINING

First Aid

Calendar Year	Total Trained
1952	34,560
1953	32,634
1954	36,649
1955	32,919
1956	32,630
1957	30,938
1958	31,941
1959 (10 Mo.)	28,420
	260,691

Coal Mine Accident Prevention Courses for Miners, Supervisors, On-the-Job and Fundamentals of Accident Prevention

Calendar Year	Total Trained
1952	27,763
1953	18,798
1954	22,937
1955	31,897
1956	19,049
1957	13,628
1958	10,116
1959 (10 Mo.)	6,265
	150,453

Metal- and Nonmetal-Mine Accident Prevention

Calendar Year	Total Trained
1952	780
1953	501
1954	361
1955	457
1956	785
1957	637
1958	904
1959 (10 Mo.)	861
	5,286

MINING GEOLOGY

By C. A. ANDERSON
Chief Geologist
U. S. Geological Survey

Researchers are studying basic geological problems in order to better understand how ore deposits are formed. Only through comprehensive knowledge of the distribution of elements in the earth's crust can intelligent exploration succeed in finding new ore deposits to supply the raw materials of an expanding industrial economy

EXTRAORDINARY demands upon our domestic mineral supplies during and since World War II have raised serious questions as to how the needs of our vastly increased industrial capacity can be met by domestic production of raw materials. In 1956, this problem was studied by the Advisory Committee of Minerals Research of the National Research Council. The stimulating report of this committee, headed by Dr. James Boyd, concluded that "In the vital task of finding new ore deposits of the bulk metals and non-metallics that will support our basic mining industry in the style—and quantity —to which modern society has been accustomed, the mining executive must place his future in the hands of modern science." The report emphasized the need for basic research into geological problems.

Intelligent exploration for mineral deposits must be based upon a thorough understanding of the distribution of elements in the earth's crust and the processes by which these elements are concentrated into ore deposits. Experimental geochemistry is a vital tool to this end. Studies of stable isotopes are leading to other important discoveries toward the same goal and advances in the determination of the precise age of rocks (geochronology) is throwing much light on problems of ore deposition. Many other fields of research are adding to the sum total of knowledge in the field of exploration.

C. A. Anderson is a graduate of Pomona College and the University of California. He taught geology at the University of California, Berkeley, until 1942 when he joined the U. S. Geological Survey. During and following the second World War he studied molybdenite and copper deposits in the western states. Between 1953 and 1958 he was chief of the Mineral Deposits Branch, and became chief geologist in August 1959.

The report of the Advisory Committee has been an important stimulus to the growth of these research programs. It is the purpose of this review, written three years later, to present a cross section of the large number of active research programs in this country, with particular emphasis on laboratory geochemical investigations that are pertinent to problems of mineral deposits.

Experimental Geochemistry

If geologists hope to sharpen their ability to predict the existence of new ore deposits on a regional, district, or mine basis, they must understand better the controls on the segregation of the ore minerals, the mechanisms of their transport, and the causes for mineral precipitation and growth at their sites of deposition. Experimental geochemistry seeks to define the stability fields of minerals and mineral assemblages, to establish the significance of compositional and structural variations of minerals, and to define within limits the physical and chemical attributes of ore-forming fluids.

Pioneer work on high temperature phase equilibria studies was done at the Geophysical Laboratory of the Carnegie Institution of Washington prior to World War II. Men trained at this laboratory and others stimulated by its program are now working at several universities and laboratories resulting in a greatly expanding program of experimental studies including sulfides, carbonates, and other systems of importance to the mining geologist.

In 1953 Kullerud of the Geophysical Laboratory published his important and fundamental paper on the sphalerite thermometer by demonstrating in the FeS-Zn system, that for ore deposits in which pyrrhotite and sphalerite crystallized together, the iron content of the sphalerite might be used to gauge the temperature of ore-mineral deposition. Skinner and Barton of the U. S. Geological Survey, in collaboration with Kullerud, have improved the experimenetal precision of the method and determined the effects of such variables as the availability of sulfur, cadmium and manganese during the formation of an ore deposit. The role of minor elements and sulfur pressure is now better understood.

Kullerud and associates at the Geophysical Laboratory are currently working on a number of systems including Ni-S, Cu-S, Ni-S, Fe-S-Se, Fe-Ni-S. A number of sulfide systems are being studied in the laboratories of the USGS, such as Toulmin's work on Fe-Cu-Zn-S, and Ag_3SbS_3-Ag_3AsS_3; Bethke and Barton's work on Pb-Zn-S-Se, Pb-ZnS-CdS, Pb-ZnS-HgS. Roy and associates at Penn State University are working on Pb-Ag-S and Ag_2S-Ag_2Se. Frueh at the University of Chicago is working on

Cu_5FeS_4. Tunell and Dickson at the University of California have recently worked on HgS-Na_2S-H_2O and HgS-Na_2S-Na_2O-H_2O. The total number of systems under investigation at these laboratories is impressive.

Bethke and Barton of the USGS, by combining phase equilibria and crystal chemistry investigations of sulfide minerals, are contributing to our knowledge of the natural controls of the erratic occurrence of economically significant amounts of trace elements, such as selenium, in otherwise common ore minerals. In providing criteria for recognizing equilibrium and disequilibrium assemblages in nature, these studies may also provide additional geological thermometers and barometers, as well as providing further limits to the chemical and physical character of ore solutions.

Silicate Studies Have Increased Knowledge of Hydrous Minerals

Experimental studies of the rock-forming silicates in the past have led to a clearer understanding of processes forming igneous rocks. The more recent silicate studies, dramatically aided by development of high-pressure hydrothermal apparatus, has increased our knowledge of hydrous minerals in metamorphic processes, zeolite formation and in rock alteration.

In association with Yoder of the Geophysical Laboratory, Eugster, now at the Johns Hopkins University, and Wones, of M.I.T., made great strides in the studies of the micas. Wones is continuing this work at the USGS. Stewart of the USGS is extending his earlier silicate studies made with Yoder and has started a study of hydrous silicates, including alteration of spodumene and the formation of zeolites. Hemley who investigated the K_2O-Al_2O_3-SiO_2-H_2O system (K-feldspar, sericite, clays) with Meyer at the University of California is extending his work at the USGS to include hydrous systems involving Na_2O and MgO. Hemley's work is intended to link with the low-temperature, low-pressure studies of Garrels and co-workers at Harvard University.

Among other hydrous silicate studies, those dealing with zeolites are becoming more prominent because of the increasing importance of zeolites in the basic chemical industry. Work on zeolites and on clay minerals, is being carried on at many institutions and industrial laboratories. Numerous publications by Roy and associates point to a directed effort on clay minerals at Pennsylvania State University, where recently an important symposium was held on zeolites.

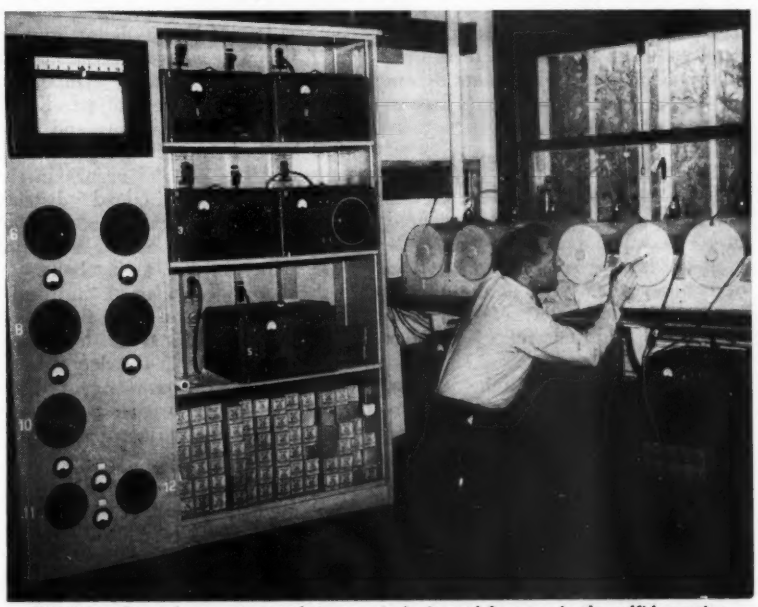
The oxidation and secondary enrichment of sulfide ores is being studied by Garrels and students at Harvard University, placing emphasis on basic chemistry. Sato has done experimental work on oxidation using sulfides as electrodes. Silman's experimental work provides basic thermochemical data on the copper minerals, antlerite, brochantite, azurite and malachite as well as providing data on the solubility of copper in ground water of known sulfate and carbonate content.

Carbonate Minerals Under Study

Fundamental research on carbonate minerals is highly desirable because of the importance of carbonate host-rock and gangue minerals in ore deposits. Goldsmith of the University of Chicago and Graf of the Illinois State Geological Survey, and their associates, are working on the system $CaCO_3$-$MgCO_3$-$MnCO_3$, and the precipitation of dolomite. Rosenberg at Penn State University has worked on the system $CaCO_3$-$MgCO_3$-$FeCO_3$, concluding that the composition of ankerite in equilibrium with calcite and siderite may provide a geologic thermometer. Holland and Oxburgh at Princeton have determined the Ca/Sr ratios in synthetic calcite and aragonite; these values permit the determination of the ratios of Sr/Ca in the solutions from which the natural minerals were deposited. Garrels and associates at Harvard are working on the mechanism of the solubility of carbonates in sea water. Jamieson at the University of Chicago, and Skinner and Stewart at the U. S. Geological Survey are studying the high temperature phase equilibria in the system $CaCO_3$-$SrCO_3$. Eugster of Johns Hopkins University is studying equilibria involved in the formation of the wide variety of unusual sodium and sodium-calcium carbonate minerals found in the Green River formation of Colorado, Utah, and Wyoming. Tuttle and Wyllie of Penn State University have completed a thorough experimental study of carbonatites leading to their conclusion of the existence of carbonate magmas.

Nature of Ore-Forming Fluids

It has long been obvious that ore-forming fluids cannot have the ore metals in simple solution; the solubilities of the sulfides are far too low. An alternative assumption is that the metal ions were present as ion complexes. The chemistry of such complexes during transport and precipitation is not well understood, although Evans of the U. S. Geological Survey has contributed important data on uranium-vanadium compounds. A better understanding of the ion chemistry of the transporting agents could be developed into a powerful tool for the prediction of ore



Checking silica tube experiments being run in horizontal furnaces in the sulfide section of the Geophysical Laboratory. Note the temperature recorder at upper left, Variacs at lower left and temperature regulators at middle and lower right

occurrence. Barton of the U. S. Geological Survey has published a paper in "Researches in Geochemistry" in which a wide range of chemical and geological data are brought to bear on the problems of low-temperature ore-metal transport. Morey and Fournier of the U. S. Geological Survey are working on the solubility of substances in the hot dense gas phases that have been involved in some ore deposition. Burnham at Penn State University has been continuing his studies of diffusion transfer in dense hot gases and the distribution of elements between melt and vapor. Barnes of the Geophysical Laboratory is studying the solubility of ZnS in fluids in the system ZnS-H_2S-H_2O at temperatures up to 200°C and pressures up to 1500 psi. Cloke (Harvard University) has studied the solubility of silver sulfide in sodium polysulfide solutions, and Garrels and his students at Harvard have worked on the solution chemistry of a number of sulfide-water carbonate-water systems at one atmosphere and 25°C.

Fluid inclusions in transparent hydrothermal vein minerals are being studied by Roedder of the U. S. Geological Survey and work to date indicates that the ore-forming fluid must have been dilute with respect to the ore elements. Chemical analyses of these fluids have also been made, showing the variation in the concentration of the major constituents in solution in the ore-forming fluids.

The chemical compositions of natural waters are being studied by White of the U. S. Geological Survey in order to develop criteria to distinguish magmatic waters from connate and metamorphic waters driven off rocks during processes of compaction and metamorphism.

Stable Isotope Studies

The present status of work in this new and promising field was reviewed in a special symposium, "The role of stable isotope research in the field or ore deposits", held at the annual meeting of the Society of Economic Geologists at Pittsburgh, November 1959.

For an element of lighter mass, for which thermodynamic properties of individual isotopes are appreciably different, a given isotope—such as O^{18}—can be thought of as a trace element, one which can be determined by mass spectrometer with great precision relative to natural variations.

Engle, Epstein (Cal Tech) and Clayton (Chicago) have used the Leadville district to show the possibilities of oxygen isotope work and their results of variations in O^{18}/O^{16} ratio of coexisting calcite and quartz show an isotopic zoning around the ore deposits. This zoning was caused primarily by thermal gradients that are not revealed by ordinary chemical and mineralogic examination of the rocks. James of the U. S. Geological Survey, with Clayton, University of Chicago, is developing further the temperature significance of oxygen isotope fractionation between coexisting iron oxides, calcite, and quartz in rocks and mineral deposits.

Craig of Scripps Institution and White of the U. S. Geological Survey have presented isotopic measurements of hydrogen, oxygen and carbon in thermal waters and material deposited from them to support the conclusion that the bulk of the hot spring waters of most thermal areas is not of magmatic origin.

Sulfur Isotope Distribution

The significance of sulfur isotope distribution is being studied by Thode of McMaster University, Ault of the U. S. Geological Survey, Jensen of Yale University, and Wanless, Boyle, and Lowdon of the Geological Survey of Canada. The latter group has shown that in the Yellowknife region the S^{34}/S^{32} ratio of sulfides is progressively lower away from granite contacts and ore. Jensen's data indicate that ores deposited from solutions of magmatic origin show a much smaller spread of S^{34}/S^{32} ratios than ores deposited from solutions not related to an igneous source.

The significance of the isotopic composition of lead is being investigated in many laboratories, and four papers in the isotope symposium were devoted to the subject. Eckelmann of Brown University and Kulp of Columbia show that an apparent zoning of Pb^{206}/Pb^{204} occurs in the Southeast Missouri lead district. Their conclusion—that the distribution indicates that earlier solutions were richer in Pb^{206}—is challenged by Brown and Synder of St. Joseph Lead Company, who show that many of the most radiogenic leads are demonstrably late in the depositional sequence. Both groups agree, however, that the lead must be derived by preferential leaching of lead from basement rocks.

Cannon and his associates of the U. S. Geological Survey have found that significant isotope variations exist in lead minerals and they offer important clues to mineral exploration and potential size of ore bodies. The lead isotope data of Murthy of Caltech has led him to cast doubt on the genetic relation between ore and the quartz monzonite in the Butte district. These are but a few examples of the fertile fields for future studies.

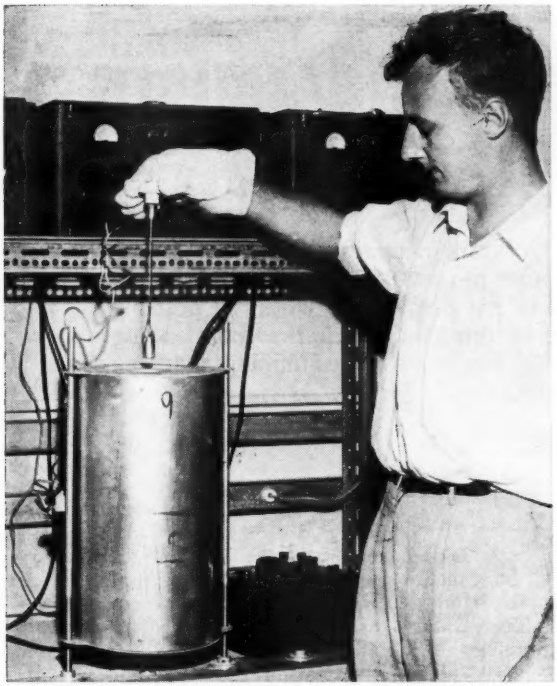
Geochronology

The search for ore deposits doubtless could be more effectively guided if the precise ages of metallogenic epochs could be established, and methods for the determination of mineral and rock ages are being developed. In addition to the methods involving uranium and thorium and their decay products, the isotopic ratios of rubidium-strontium (Rb/Sr) and potassium - argon (K^{40}/Ar^{40}) now are being widely used for age measurements of many common rock-forming minerals. The general concordance of results by various methods justifies increasing confidence in their use.

Active programs of age determination have been inaugurated and extended at the Carnegie Institution laboratories by Aldrich and associates; at the U. S. Geological Survey by Faul; at the Lamont Observatory of Columbia University by Kulp and associates; at M.I.T. by Hurley, Fairbairn and associates; at Caltech by Silver; at the University of Minnesota by Nier, Goldich and Gast; at the University of Arizona by Damon; at Rice Institute by Adams; at University of Toronto by Wanless; at University of Alberta by Folinsbee; and at Montana State University by Hayden and Hower.

Much of the work at these laboratories has been on development of methods and instrumental techniques and appraisal of complicating geological and chemical factors. Work on selected topics, however, is yielding data that are of interest to problems of ore search. The Sierra Nevada batholith and similar batholiths along the Pacific Coast from Alaska to Mexico appear, for the most part, to be in the range 80 to 100 million years in age. The Duluth lopolith is about 1100 million years old—appreciably younger than the Sudbury intrusive with which it has often been correlated in the past. The ore deposits of the Coeur d'Alene district, generally held to be Laramide in age, have been shown to be at least in part as old as 1000 million years (Precambrian).

The standardization of the Sr/Rb and K/A techniques and improvements in the lead/alpha technique give reason to hope that one or more laboratories can be established on a service basis to provide needed age determinations to geologists not



Placing charges of synthetic sulfides in furnace. Note temperature regulators in background

closely connected to one of the research laboratories.

Geochemical Prospecting

Geochemical prospecting has been well established as a prospecting method, as demonstrated by the fact that ore was found in 44 percent of the projects financed in part by Defense Minerals Exploration Administration loans and based in part on geochemical data. New techniques as well as modification of old techniques continue to be developed.

Field detection of beryllium has been given a boost by the new portable "Berylometer," described by G. M. Brownell in the Sept., 1959, issue of *Economic Geology*. This instrument makes use of the well-known reaction Be^7 $(\gamma,n) = Be^6$ to detect the presence of beryllium in rocks or specimens, and offers a rapid reconnaissance method of assaying. The U. S. Geological Survey at Denver has had a similar type of instrument, developed independently by Vaughn, for use in fixed or mobile laboratories.

The use of water analyses as a prospecting method has fallen somewhat in favor in recent years, largely because of the lack of sensitive analytical methods for many elements. Ion-exchange resins, however, now can be used to concentrate traces of metals from large volumes of water and greatly increase the sensitivity of water analysis. As a result some companies are beginning to reappraise the possible usefulness of water analyses for prospecting. The Geochemical Exploration Section of the U. S. Geological Survey has developed ion-exchange techniques for Cu, Pb, Zn, Co, Ni and Mo, by which it is possible to measure concentrations of these elements as low as one part per billion or less.

Burnham has recently published (*New Mexico Institute Mining Bulletin* 65, 1959) a paper showing how some of the metallogenic provinces of southwestern United States are defined by the geographic distribution of trace or minor elements in chalcopyrite and sphalerite. Warren and Delavault of the University of British Columbia have demonstrated that measurement of metal concentrations in igenous rocks may yield prospecting guides (*Economic Geology*, November, 1959).

Ore Metals in Intrusive Stocks

Griffitts of the U. S. Geological Survey has found that the content of ore metals from intrustive stocks is related to the abundance of the metals in the ore bodies associated with the stocks, as for example the zinc content of the stocks is high in zinc districts. The high contents of copper and zinc in the igneous rocks results from an introduction of metal during mineralization rather than a high metal content of the original magma. These metal-rich rocks mark dispersion haloes that may be used in search for centers of mineralization.

Hawkes and associates at the University of California are working on a technique to determine very low concentrations of mercury in soil gases and air, the objective being to locate haloes around buried ore bodies; also being developed is a new means of detecting silver in very low concentrations in soils and rocks.

R. W. Boyle and others of the Geological Survey of Canada are planning a major field test in the Central Patricia district of Ontario in which the area will be thoroughly studied by all geochemical techniques in combination with geologic mapping.

Geophysics

Geophysics has played an important role in the mining industry—as is shown in the recent compilation of geophysical case histories by the Canadian Institute of Mining and Metallurgy and the European Association of Exploration Geophysicists —but it has never had the wide use in mineral exploration that it has had in the search for petroleum. The difference is in part due to the difference in size of target.

Future progress in the art of geophysical exploration for minerals will require a detailed knowledge of the relation of physical properties to mineralogical and chemical composition, knowledge which we have just begun to acquire. Some magnetic properties of rocks have been related by Buddington of Princeton and Balsley of the U. S. Geological Survey to changes in mineral composition. Keller of the U. S. Geological Survey has related the dielectric constant and resistivity of rocks on the Colorado Plateau to water content and indirectly to the occurrence of ore.

Induced polarization and its relation to sulfide ores, originally proposed by Bleil of the Naval Ordnance Laboratory shortly after World War II, is being investigated by many workers, including Marshall and Madden at M.I.T. Studies of the elastic and acoustic properties of rocks underway at the Geological Survey and in industrial and university laboratories hold considerable promise, and the possibility of relating radio-activity to elements besides uranium is an intriguing one.

ACKNOWLEDGEMENT:

Grateful acknowledgement is made to many of my colleagues on the U. S. Geological Survey who have helped generously in the preparation of this review article.

MECHANICAL COAL MINING

By D. L. McELROY
Vice President—Operations
Consolidation Coal Co.

The manufacturers of mining equipment probably made more progress for the coal industry in 1959 than in any single year with the possible exceptions of those in which the first loading machine and first continuous mining machine were introduced

THE year 1959 was a trying one for the U. S. coal industry. Coal prices were generally lower, wage rates increased in April in accordance with a wage contract negotiated in the fall of 1958, the flood of foreign oil and dump gas continued and then the steel strike came. All of these factors were quite a burden for the industry to bear.

In spite of all these problems bituminous production in 1959 is estimated at 410,000,000 tons, the same as in 1958. Generally, from a market requirement standpoint, coal business was improved in 1959 and production would probably have been around 430,000,000 to 435,000,000 tons if there had been no steel strike. Utility coal sales increased in 1959 but not as much as did sales of oil and gas, particularly in the East. Exports of coal continued to fall, due primarily to the glut of excess coal capacity and production in Western Europe.

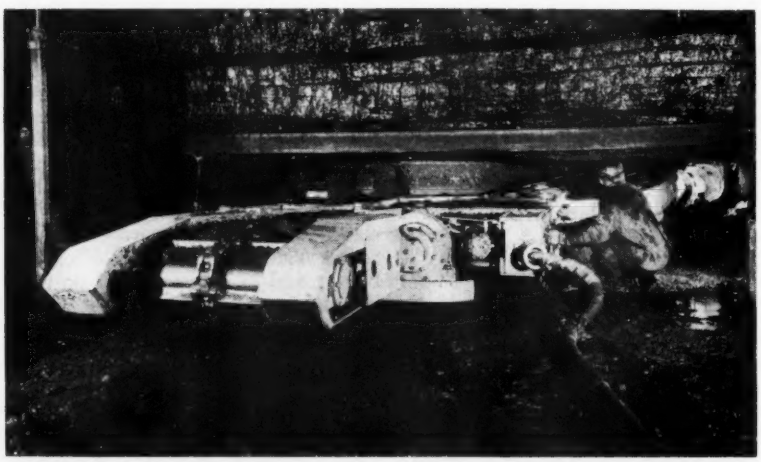
The Federal Government in 1959 finally gave recognition to the impact of foreign oil on the U. S. economy by imposing quotas on the importation of such oils including residual which has been so harmful to U. S. coal production, particularly along the Atlantic Coast. These restrictions were a help because they did *slow down* the *increase* in importation of residual fuel.

Early in 1959 the National Fuels Policy Conference was formed by a group of coal operators, the United Mine Workers, Eastern railroads, some utility companies and manufacturers of mining equipment to promote the formation and subsequent enactment of a national policy on fuels in the United States. The general plan would be to study the present and future fuel needs of the United States, the present and possible sources of the fuel for these needs, the availability of these sources under varying circumstances (such as war) and to set a government policy as to what minimum volume of available production of each fuel from their various sources should be maintained.

In order to better compete with dumped residual oil on the East Coast, coal companies reduced the price of coal to the utilities in the North Atlantic and New England states, and the railroads serving those areas reduced freight rates on coal provided the utilities took minimum agreed tonnages to their plants. This move no doubt saved considerable coal tonnage that would have gone to oil and gas.

On the labor front things were normal and quiet, with a minimum of local strikes and disputes. Except for the effects of the steel strike coal mine employment was probably some better than in 1958.

The coal pipeline from Cadiz, Ohio, to Eastlake, Ohio, had its first full year of operation in 1959 and moved approximately ten percent more than its designed capacity.



Equipment manufacturers concentrated on developing thin-seam mining machines

Importance of Mechanization

With generally lower prices and increased wage rates, the need and importance of improving performance and reducing costs of mining coal in 1959 became even more important than during the last few years. This situation meant that the industry had to take lower profits or reduce costs —in general the industry did both.

The basic way the coal industry has maintained a generally stable cost picture with increased labor rates and supply prices has been by increasing

Mining man, educator, engineer and author—Dennis L. McElroy is certainly well qualified to review "Mechanical Coal Mining" for 1959.

His educational experience includes serving as head of the Mining Engineering Department, Virginia Polytechnic Institute, and director of the School of Mines, West Virginia University. During World War II he was chief of the War Production Board's Coal Section. Employed as chief engineer of Consolidation Coal Co., Fairmont, W. Va., he became successively vice president-engineering, Pittsburgh Consolidation Coal Co., and vice president-operations, Consolidation Coal Co., Pittsburgh, Pa. He is also a director of Consolidation Coal Co., Christopher Coal Co. and Pitt-Consol Chemical Co.

Former editor of the "Coal and Coke Section" of the *Mineral Industry Yearbook*, McElroy is the author of *Coal Mine Haulage in West Virginia; Study of Mechanical Loading in West Virginia Coal Mines;* and "Coal-Mining-Engineering," a section in the McGraw-Hill *Encyclopedia of Science and Technology*.

The swing to a-c continued, with all manufacturers of face equipment now offering both a-c and d-c powered machines

productivity through mechanizing the mining of coal. Although final data are not available, the tons per man per day at underground mines may pass ten for the first time in 1959. In fact the productivity of American coal mines has approximately doubled in the last twenty years. This was made possible by the foresight of both the operators and the United Mine Workers in recognizing that only in that manner could the industry hold its markets and expand into others.

The improved efficiency, however, was not a gift. With it came very substantial increases in wage rates and fringe costs as well as the investment of hundreds of millions of dollars in new types of equipment. The cost sheet of a new mine today can, and often does, show depreciation costs as high as supply costs and close to labor costs. Mechanization reduces production labor costs but it is not a net gain as labor maintenance costs, supply costs and depreciation costs invariably increase.

Operating Factor—How Can Breakdowns Be Minimized?

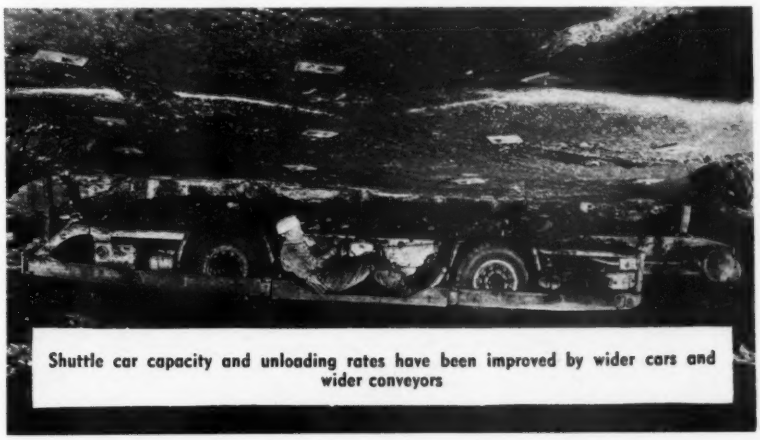
A study of mine costs in general will show, it is believed, that the best way for the industry to make a substantial reduction in present costs is to get more operating time out of the equipment used. No other major industry would permit the 30 to 50 percent operating time per shift that is so common in coal mining. Imagine a strip mill, a power plant generator, a truck fleet or any other major piece of equipment in other industry running only one-half of the time. It is common to have such poor operating rates on underground mine equipment but big strip shovels run 95 percent of available time. Picture the improvement in the production on a section in a coal mine if the "down time" was cut in half.

Probably the largest factor in keeping down the operating factor on underground mining equipment is the matter of so many breakdowns, although mining conditions can and do, of course, hinder the full operations of equipment. How can these breakdowns be reduced to the minimum?

First, the equipment must be designed so that it will stand up to the duty inmposed upon it. Weak points and units must be designed to last as long as other components on the machine. This may mean use of different design, better metallurgy, or heavier construction where needed. These changes may cost more money, but if they improve operating time 25 or 50 percent it is not likely that the increased cost would be a poor investment.

Second, well thought-out and properly executed maintenance programs must be put into effect. Preventive maintenance is a matter of much conversation about coal mines, but far less of it is actually done. Records must be available to show what maintenance needs to be done and when. No maintenance program, no matter how well planned, will succed without competent people to execute it. A lot of equipment has been thrown at mine organizations and generally faster than they could adapt themselves to it — particularly maintenance-wise. Basically, mine labor is as intelligent and willing as any to be found, but they must be trained to know this machinery—how to properly run and maintain it. Operating time on mine machinery indicates that the industry has stumbled pretty badly on this point.

Coal operators must insist on mining equipment with no major weak points like a few hundred dollar component that shuts down a $125,000



Shuttle car capacity and unloading rates have been improved by wider cars and wider conveyors

piece of equipment every few shifts. Also they will not get a good maintenance program through the mail or have top-notch maintenance men coming to their office for jobs. We might just as well get busy and put our intelligence and effort to devising a good program and training the men to follow it through.

Developments in 1959

The manufacturers of mining equipment probably made more progress for the coal industry in 1959 than in any single year with the possible exceptions of those in which the first loading machine and first continuous mining machine were introduced.

A-c power for underground equipment continued its growth materially, particularly in the development of new coal mines. This certainly is a trend in the right direction for both cost (particularly maintenance) and safety. All manufacturers now offer complete complements of section equipment in both a-c and d-c power.

Manufacturers came out with a redesign of loaders, shuttle cars and continuous mining machines in 1955 that were more rugged, of higher capacity and indicated lower maintenance costs. Designs for full complements of equipment to mine seams as low as 25 in. are available from most manufacturers. This includes continuous mining machines, loaders, shuttle cars and cutting machines.

Important improvements in these redesigns include much better accessibility of motors, gears and other components. Shuttle car capacity and unloading rates have been improved by wider cars and wider conveyors. In general the 1959 equipment is more rugged than previous models.

One manufacturer acquired the remotely controlled continuous mining machine which had been developed by a chemical company and is engineering a complete remotely controlled mining system around the machine. All functions are to be controlled from one point including the mining, transportation and moving of all equipment in and out of the working area. The first working unit is projected to be in service in 1960.

Several manufacturers have available simple remote control units for use on continuous mining machines. The use of such units can be very helpful on pillar work. A great number of the present cases of machines covered up in pillar falls could be averted by such a unit. When roof begins to work the operator has no choice but to go to a safe place—and watch the machine be covered up. Often the actual fall does not come for minutes—sometimes quite a few minutes. With remote controls in a safe place, a majority of the time the machine could be trammed out before the fall—even part way would help. This would save the cost of recovering and repairing it and save the production lost while out of service.

Greater ground clearance on several machines has helped their production, particularly in pillar sections with soft bottom.

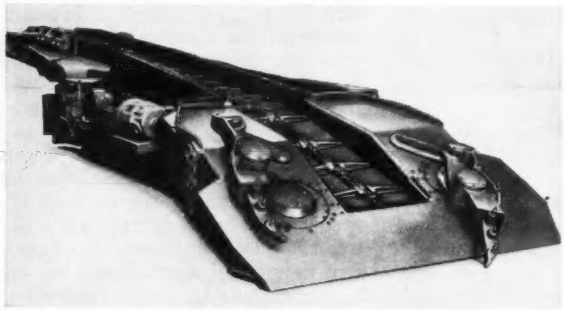
One manufacturer has designed and built equipment for what they call "Full Dimension" mining which has so far been quite successful. It includes loading machine, bridge conveyors and main conveyors. (*Mining Congress Journal*, November 1959).

Rope conveyors, improved in design and construction, continued to be popular for efficient, low cost conveying in coal mines—both thin and thick seams.

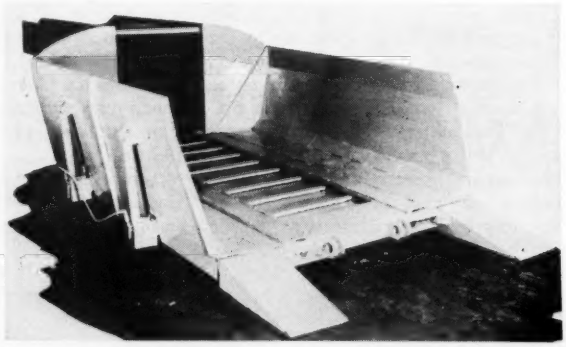
A manufacturer is offering a British design of main conveyor belts where the belt is conveyed by two outside wire ropes. It is being used in British and Canadian coal mines. It claims to be about same first cost but uses cheaper belt due to all tensions and stresses being on the wire ropes instead of the belts.

Several companies offered belt feeders during 1959. Basically they are hoppers into which shuttle cars discharge at fast rate and the feeder discharges at lower rate into a belt. Users claim they cut delays in shuttle car hauls and give better loading on belts. They permit more units on one belt and give more uniform belt

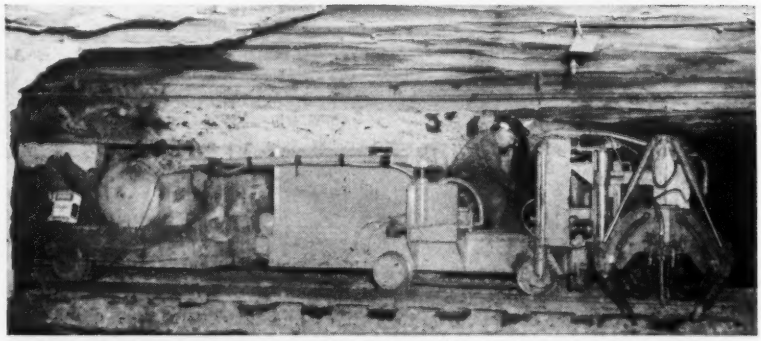
(*Continued on page 49*)



A new type low-and-medium-vein, high-capacity loader. Productivity of American coal miners has approximately doubled in the last 20 years



Sides of belt feeder can be closed upward to facilitate cleaning and tramming



A mine-track tamper and track-material-handling machine came on the market in 1959

MINERAL DRESSING

Chipping away on the problem of how to get the most net dollars out of a given ton of ore, metallurgists made steady progress in the search for more efficient methods of ore treatment

By E. C. HERKENHOFF
Director of Technical Services
Marcona Mining Co.—U. S.

THE generally depressed markets in lead-zinc, the steel strike and the long walkout against the major copper producers tended to put a damper on research money and effort. The Lake Superior iron ranges, famed incubators of new machines and ideas, were shut down by the steel strike, and the numerous ore treatment plants were regrettably non-productive of concentrates or test results. The huge taconite plants at Hoyt Lakes and Silver Bay were shut down from July 15 to mid-November; the seasonally-run lean ore plants could not be reopened because Nature conspired against the operators by sending early cold weather. As a consequence, shipments of iron ore from Lake Superior ports fell to 42,650,729 tons, the lowest since World War II.

Domestic uranium ore processing forged ahead, approaching a production plateau, with new mills put into operation by Kermac Nuclear Fuels Corp., Phillips Petroleum Co., Federal Uranium Corp. and Union Carbide Nuclear Co. The Ambrosia Lake area fought the battle of producing ore in spite of ground water, and mill men faced the additional requirement of drying ores in order to facilitate handling in their circuits. The Atomic Energy Commission's announcement that Canadian uranium producers' contracts would not be extended beyond 1961 poundages gave little comfort to domestic producers' hopes for renewed contracts and stable prices after 1966. Accordingly, there is grim determination and genuine necessity to reduce the costs and prepare for the competitive market ahead.

Earl C. Herkenhoff received his formal education at New Mexico School of Mines and University of Idaho. From 1937 to 1940 he worked successively for New Jersey Zinc Co., Phelps Dodge Corp. and Anaconda Copper Mining Co.—both in mining and milling. After ten years with American Cyanamid Co. in research and field work, he joined Pickands Mather & Co. in 1951 and in 1955 became associated with Utah Construction & Mining Co. In September 1959 he became director of Technical Services for Marcona Mining Co. His broad experience in research and development makes him well qualified to review the progress of mineral dressing during 1959.

Trend Toward Larger Grinding Mills Continues

The trend toward larger grinding mills continued and more attention is being directed toward the autogenous grinding mills, with the advantages of lesser expenditure for crushing circuits and lower steel and power consumption.

Quebec Cartier selected Hardinge Cascade mills for grinding its Lac Jeannine specular hematite ores, a significant boost for the use of autogenous grinding mills. These "standard" mills are only 18 ft in diameter; it is rumored that 30-ft diameter mills are being considered by certain manufacturers.

From South Africa, where pebble milling has received intensive study for many years, Dr. O. A. Jackson reported on pebble milling practice at the numerous mines of Union Corp., Ltd. Excellent detailed data are presented in the November issue of *Mining Engineering*. Mills of 12 ft diameter by 16 ft long are in successful use and pebble milling is now carried out in three stages. Dr. Jackson concludes that the cost of producing suitable pebbles is unlikely to advance as fast as the price of steel grinding media, and those mill men who agree with this premise should give pebble milling serious attention.

In February, A. W. Fahrenwald

Flotation — an important tool that is constantly being improved for wider application

Fine particles of iron ore are separated from waste material by a magnetic process. Domestic equipment manufacturers continued research on high intensity magnetic separators and electrostatic type separators

reported on progress with his gyratory ball mill, a new type grinding unit not subject to the limitations of "critical speed." With capacities of four to five times those of the conventional mills per unit of ball load, industry should carefully follow developments in this new machine, commercial sized units of which are reported to be available soon.

Several Iron Ore Beneficiation Projects Started

In iron ore, the insistent demands of the blast furnaces and sintering plants for better prepared, high-iron feeds spurred the completion of many foreign ore beneficiation projects and the start of several major new ones. There was fortunately no recession in this specialized area of mineral dressing—indeed, it was the outstanding opportunity in the entire field.

At Moose Mountain, 35 miles north of Sudbury Lowphos Ore Ltd. completed construction of its low grade magnetite processing plant, with shipments begun shortly after April 1. It is significant that this is an operation which mines and produces fine magnetic concentrates but does not agglomerate the concentrates. They are shipped to various consumers for blending with standard sinter plant feeds. High lights of the operation are the fine grind (90 percent minus 325 mesh) and high iron content in the concentrates, up to 69 percent Fe.

The Vermillion Range at Ely, Minn., since 1892 a famous source of high grade, dense, open hearth lump ore derived from underground mining, is the site for the installation of a 200 tph washing plant to treat the minus 1¼-in. fraction of the run-of-mine ore from the Zenith mine. This type of development is the only way the old producers can fight back for the markets which have been going to higher grade, lower cost foreign producers. Significant also is the recognition that lower taxes must be an adjunct to improved mining and processing equipment and techniques —the State of Minnesota legislators took at least some action to encourage local producers by reducing taxes and by passing a new tax law to encourage treatment of lean ores classed as "semi-taconites."

Cleveland-Cliffs Iron Co., leading the field in the pioneering of hematite processing by froth flotation and agglomeration, announced that the capacity of its Humboldt mine (320,000 tons of product per year) would be doubled, and that a new pelletizing plant, using the new Allis-Chalmers Grate-Kiln process, would be constructed. This plant is to have a capacity of 2000 tpd in two 1000 tpd units. All industry is watching this because it will be the first commercial-sized installation of the grate-kiln process. Completion is scheduled for about May. Processing in each circuit calls for treating the 60 percent Fe concentrate in two 9 by 30 ft balling drums, thence over vibrating screens to remove undersize material, with oversize to a chain-type grate, 9 ft 4 in. wide and 71 ft long. Preheated and partially hardened balls will discharge directly into a rotary kiln 10 ft in diameter by 120 ft long for final hardening. Kiln discharge will be cooled in a 25-ft diameter annular cooler.

Up in Steep Rock, Canada, the new South Concentrator for Steep Rock Iron Mines, Ltd., joined its sister plant, the North Concentrator, in producing "coarse" concentrates from the various lean ores. The plant incorporates standard washing, dense medium, jigging and spiral recovery methods.

On the Menominee Range at Groveland, Mich., Hanna Mining Co. started up its new Groveland plant having a capacity of 700,000 tons of concentrates per year. Here concentrates are produced by a combination of spiral concentration and froth flotation (of the iron minerals)—but again no agglomeration plant has been installed; studies continue.

Development of Canadian Iron Reserves Progresses

Dwarfing all the foregoing in sheer size and inevitable impact on the domestic industry were the announced projects of Quebec Cartier Mining Co., Pickands Mather's Wabush Iron Co., and Iron Ore Co. of Canada's Carol Lake development. All these projects are based on the huge iron deposits along the Labrador-Quebec trough. Units for expressing concentrate reserves are millions of tons, and costs for putting projects into operation in that area are measured in the millions of dollars. Mineral dressing engineers, both present and future, all have a stake here because there are many ores of differing character but all require processing in some manner.

Quebec Cartier moved ahead on schedule with its $200,000,000 to $300,000,000 project to build, among other things, a concentrator having a capacity of 60,000 tons daily which should yield 8,000,000 tons of concentrates annually. The treatment scheme is reported to be wet grinding in 12 Hardinge 18-ft diameter by 5-ft Cascade mills, with concentration in Humphrey spirals. The spiral concentrates are to be dewatered and thermally dried in FluoSolids type of dryers prior to rail shipment to the dock at Port Cartier, 190 miles distant on the Gulf of St. Lawrence. The concentrates, about minus ten mesh in particle size, are

said to be high grade, 66 percent Fe. Determination of the best method for agglomeration is actively under study.

Wabush Iron Co. started construction of the railroad spur westerly from the Q.N.S. & L.R. Line to the Wabush Lake area and planned operation of a large pilot plant to confirm its flow scheme. IOCo's Carol Lake project calls for a plant to produce 6,000,000 tons of concentrate per year with production in late 1962. Both wet and dry magnetic separation, electrostatic separation, and gravity concentration are known to be under consideration for these plants.

During the year, Anaconda decided to erect a pilot plant for the processing of a magnetic taconite type of deposit near Nakima, in northwestern Ontario, but details of the proposed scheme are not known. In the same general area, Jalore Mining Co., a wholly-owned subsidiary of Jones & Laughlin Steel Corp., continued to evaluate a large deposit of iron formation containing about 25 percent magnetic iron. Farther west, in the Steep Rock area, Canadian Charleston proceeded with operation of its novel plant for recovering iron ore from crude gravels. Gravel containing from 5 to 25 percent Fe is treated by gravity methods to recover a 58 percent Fe concentrate, at lean ratios of about ten to one.

Out West, Columbia-Geneva Steel pursued its engineering studies for the large "taconite" processing plant intended for the treatment of the Atlantic City, Wyo., ore. Agglomeration of the finely ground concentrate is to be by traveling grates.

Base Metals Continue Efforts to Improve Efficiency

Kennecott reported on the application of its Leach-Precipitation-Flotation process to the Ray Mines Division concentrator at Hayden, Ariz. With 2½ years of use at an average of 16,000 tpd, performance data should be quite reliable. Key steps in the process are: 1) separation of rod mill product into sands and slimes; 2) acid leaching of the sands, followed by ball mill grinding and flotation in a lime circuit, with pyrite recovery from the copper flotation tails; 3) sponge iron and sulfuric acid manufacture from the pyrite; 4) acid leaching of the slime fraction with precipitation of the dissolved copper on sponge iron; 5) flotation of the precipitated copper and sulfide copper, and, 6) magnetic recovery and recirculation of sponge iron. Details of this complicated but highly interesting flow scheme were reported by A. W. Last in the October issue of *Mining Congress Journal*.

Southern Peru Copper Company's huge new Toquepala project was completed in September and the mill began shake-down operations during that month. Milling is by conventional fine grinding and froth flotation. It is interesting to observe that mechanical classifiers were installed rather than cyclones, and mill men may speculate as to when and if cyclones may replace the classifiers to make room for more grinding mills, should the present industry trend continue.

The Tri-State and Lead Belt operators continued to feel the heavy hand of foreign competition and determinedly improved costs and production. H. A. Hoffman reviewed recent milling progress and took a look ahead in an article appearing in the September *Engineering and Mining Journal*. He predicts, among other things: gravity concentration will be supplanted by all flotation; mechanical flotation machines will replace pneumatic machines; more use of cyclones; automation of material flow; automatic reagent controls; quick, continuous analytical devices; closed circuit television; radio communications and improved maintenance techniques.

Joining the ranks of the domestic copper producers was Duval Sulfur and Potash Company's Esperanza mine, 33 miles southwest of Tucson. Novel in the flow scheme of the concentrator are the world's largest rod mills; each of two mills is rated at 250 tph capacity. These mills are Marcy 12½ by 16 ft and are powered by 1500-hp motors. Following the trend in most fine grinding mills, cyclone classifiers are used. A molybdenum concentrate is also produced. Extensive use of instruments and automatic controls is reported and the industry will carefully watch the outcome.

Another producer-to-be for the Tucson area is American Smelting & Refining Company's new Mission mine. Plans for a 15,000 tpd operation were announced late in the year and a design engineering contract was awarded to Western Knapp Engineering Co.

The domestic lead-zinc producers, ever squeezed between rising costs and fixed or falling prices because of foreign competition, continued efforts to improve efficiency. Shattuck Denn at Prescott, Ariz., was successful in modifying its mill flow sheet to increase "economic recovery" from 66 to 84 percent. Mill men facing similar problems with complex lead-zinc-copper ores should study the article describing how this was ingeniously achieved (*Mining World*, October 1959).

Getting even the "squeal" was revealed in detail by Climax Molybdenum Co. in the November issue of *Mining World*. Although the by-products plant started operation in 1958, it has since been improved and expanded in capacity to 32,000 tpd. Clever use of gravity concentration, froth flotation of both sulfides and non-metallics, and dry, high intensity magnetic separation has resulted in successful recovery of tungsten, tin and pyrite products. There are also some good tips on mill design in the new by-products plant.

And while on the subject of the "squeal," it is of interest to learn that the Mexican government has been studying the possibilities for retreating the 55,000,000 tons of old cyanide tailings in the Pachuca area. (With heads of only $1.50 per ton, even the squeal is faint!) A plant having a capacity of 7500 tpd was scheduled for operation late in 1959. Reclaiming of tailings by monitors, discard of primary slimes by cyclone classification, with standard sulfide flotation of the sands after regrinding, is the reported treatment scheme. Complete details can be found in the November-December *Trefoil* of Denver Equipment Co.

Progress in automation at Anaconda's mill in Anaconda, Mont., was reported by J. R. Moore in *Mining Congress Journal* of November 1959.

The method for feeding milk of lime should be of special interest to most mill men. Adjustable timers and solenoid valves on a special type rubber sleeve valve are the key to the solution, and permit automatic control if desired. Feeding of the lime slurry is by short period, timed intervals for full flow through the valve, thus elimnating the old nuisance of trying to maintain a small-volume, steady-flow from a restricted orifice which is susceptible to plugging by small tramp foreign matter.

Late in the year, General Electric Co. advertised its X-Ray Analysis machines which are reported to analyze continuously up to six elements in a stream of slurry or dry solids properly presented to the unit. Although it may be some years before such units can be "de-bugged" and brought

Kermac Nuclear Fuels Company's new acid-leach, solvent extraction plant, one of the largest uranium mills in the United States, went into operation in the Ambrosia Lake area near Grants, N. M.

down to price levels acceptable to small ore processors, the trend is toward rapid analytical determinations and process control thereby. Meanwhile, mineral dressing engineers must focus attention on means for obtaining better, cheaper and more representative samples for these new analytical machines—often as much or more of a problem than getting the mere analyses out of an instrument!

New Treatment Schemes Cited

Under the heading of "new treatment schemes" was the announcement that Oreclone Concentrating Corp. operated its small concentrator near Virginia, Minn. Hematite-bearing tailing pond fines were treated through "oreclones," a special type, semi-cyclone vessel, with underflow further upgraded on an inclined belt concentrator akin to the old vanners of early base metal gravity plants.

At the Riverton, Wyo., operation of Lucky Mc Uranium Co., a novel method for treating submarginal uranium ores was put into operation. Run-of-mine submarginal ores are carefully placed into beds over a prepared drain field, and then are heap leached with mill barren solution which contains about five grams per liter of sulfuric acid. The pregnant solution leaving the drain fields is collected and pumped to a central storage tank and the uranium is extracted by passing the solution through the column ion-exchange circuit of the existing mill.

Believed to be the first commercial-sized plant for the processing of "coarse" iron ores in sea water, the fines beneficiation plant of Marcona Mining Co. at San Juan, Peru, was placed into operation in early 1959. This 200 tph plant processes minus ¼ in. by 0 fines screened from Marcona's direct shipping ores, using a combination of Dings wet magnetic separators and special Yuba jigs. To date over 1,500,000 tons have been processed with no particular problems resulting from the use of the sea water. (It may be recalled that Sydvaranger in Norway processes a taconite material by fine grinding and wet magnetic separation—all in sea water.) Marcona plans an expansion in ore processing facilities and will shortly commence construction of a wet scrubbing, magnetic cobbing, and dense-media plant for handling plus ¼-in. ores.

Other Developments Highlighted

Uranium ore processing merits much more space than can be given here. However, high lights included Kermac's new acid-leach, solvent extraction plant. The largest uranium mill in the U.S., it went into operation in the Ambrosia Lake area near Grants, N. M. Neighboring plants, treating ores from the same area, mostly use alkaline leaching-filtration schemes, and include the Homestake-Sapin, Homestake-New Mexico Partners, Phillips Petroleum and a portion of Anaconda's Bluewater mill.

In the Moab area, Uranium Reduction Co. announced plans to convert an acid leach circuit to alkaline leaching in order to handle high lime ores. The government-owned Monticello plant using alkaline leaching and R-I-P processing was scheduled to close at the end of the year.

In the research laboratories of the iron mining companies, universities and Bureau of Mines, attention has been focused on methods for processing lean hematite ores and semi-taconites. Indeed, even the beneficiation of "paint rock" (akin to ferruginous kaolin) is being examined, but all indications are that the basic tools for such work must be cheap, effective reduction roasting methods followed by magnetic separation, rather than presently used gravity and flotation methods.

The merits of dry magnetic separation versus generally accepted wet magnetic processing are being carefully weighed but unit capacities, removal of moisture, and initial cost cast shadows over the preliminary economics based on the promising sharp mineral separations. P. E. Cavanaugh reported in the March issue of *Mining Congress Journal* on results obtained in the pilot plant of Ontario Research Foundation in Toronto. This plant flow scheme involved dry-grinding in an Aerofall mill with separate treatment of two size fractions in specially designed dry magnetic separators called "Fast Eccentric Drum" and "Double Helix." Domestic equipment manufacturers continued research on high intensity magnetic separators and electrostatic type separators. The Dings Co. in Milwaukee announced its new "Coronatron" electrostatic separator, developed initially for cereal grain processing. The company reports exceptionally clean mineral separations and relatively low capital costs for such units.

In fluid-solids separation, so vitally important in most ore processing methods, new "super" flocculants were announced by American Cyanamid Co. Progress continued in the design of mechanical features of filters, in the filter media, removal of cake (such as by snap-blow, scrapers,

rollers, strings, and removable cloth) as well as in the agitation of pulp in the tank.

The "tough nut" problem of oxidized copper recovery received some share of research work in 1959 and the Bureau of Mines disclosed results of tests using the "Segregation Process" in RI 5501. Copper minerals are roasted with salt, then reduced with carbonaceous material to metallic copper. Flotation then is applied for copper recovery from the gangue. The economics are questionable.

In Europe, coal producers are reported to have found that fine coal (minus ½ in. plus 35 mesh) can be cleaned practically by using Dutch State Mines cyclones and magnetite medium. Using an improved, simplified flow scheme, medium losses per ton of feed are reported to range from 0.7 lb to 1.5 lb. Improvements are centered about eliminating the densifier, using a low pressure horizontally-positioned cyclone rather than the former high pressure vertical cyclone, reducing the number of vibrating screens for draining and washing, and only single-stage magnetic separation. All such improvements should reduce the capital cost per ton of capacity and make the process more attractive to domestic producers. Complete details can be found in an excellent article by Dr. C. Krijgsman in the May and June issues of *Mining Congress Journal.*

Effort to Improve Iron Ore Pelletizing Processes Intensified

Intensive effort to improve iron ore pelletizing processes and lower agglomeration costs continued and even accelerated. Erie Mining Company's shaft furnaces at Hoyt Lakes were reported to be under modification, and it was announced early in the year that two experimental pelletizing furnaces would be added to the existing 24 production units. In the meantime, pellets from the Hilton mine near Ottawa, produced in Erie-type shaft furnaces, were in high demand by consumers and an increase in concentrator capacity at the Hilton was approved. Research on shaft furnaces was continued by Bethlehem Steel Co. at Lebanon, Pa., with reported substantial improvements centered about heat exchangers on the lower portion of the furnace. Reserve Mining Co. continued to improve the performance of its traveling grate pelletizing units at Silver Bay, both as to hardness of product and low Btu consumption per ton, with considerable credit given to a better concentrate received from the mill. The steel strike halted all full scale work in mid-year, and operations did not resume until late November.

The Grate-Kiln process, developed by Allis-Chalmers, continued to be studied in the company's pilot plant (details in the September issue of *Engineering and Mining Journal*), and the first commercial units were under construction for Cleveland Cliffs Iron Co. near Ishpeming, Mich. Operation of these first units is scheduled to begin in May, as mentioned earlier.

Manufacture of briquettes for use in open hearth steel making was actively studied and holds promise as another outlet for iron ore fines, both natural and concentrates. Here the requirements for large size, high grade and high density agglomerates pose special problems for the ore producers and processors.

One interesting method, for producing a feed to open hearths from low grade ores, spans the entire gap between concentration and agglomeration within the process itself. This is the R-N process, sponsored by Republic Steel and National Lead Co. A large pilot plant at Birmingham, Ala., has successfully demonstrated the technical feasibility of the method. To mineral dressing engineers it is of particular interest because it is the one "direct reduction" process which beneficiates or up-grades the ore enroute. Wet grinding mills, magnetic separators, coke tables, and filters are a part of the process. Final product, at 90 percent Fe or more, reportedly can be charged directly to steel making furnaces.

MECHANICAL COAL MINING

(*Continued from page 44*)

loading. In many cases it has been possible to slow belt speed and handle more coal. One operator said he would use the belt feeder if improved belt maintenance was all he achieved. The design of one manufacturer has sides which can be closed upward to clean feeder and also be only 60 in. wide when closed for tramming. The conveying conveyor drive and flights on this unit are interchangeable with the same parts on the shuttle car manufactured by the company.

A mine-track tamper and track-material-handling machine came on the market in 1959. Operators using it say it not only materially reduces cost of laying and maintaining track but does a better job of track work than possible before.

At least two companies have brought out roof drill units which remove the dust through a hollow drill steel. This greatly simplifies dust handling. Some problems have been encountered where the roof is wet. For difficult roof bolt drilling one company has developed a rotary-impact drill to try to get at least away from air drilling under such conditions.

All mining machinery manufacturers in the continuous mining field claim to be working on the engineering of new types of continuous mining machines. Some of these will be introduced in 1960.

Two developments in fighting mine fires were introduced in 1959. One company brought out a bagged dry extinguishing agent which can be applied by hand, shovel or through a rock-dust machine. It is supposed to be suitable for all classes of fires. A newly formed company has developed the equipment to generate a foam which is then moved through the mine entries by fan pressure. The foam fills all the voids and extinguishes any fire encountered. Its demonstrations have been quite spectacular.

For mine rescue work and fire fighting where masks are required, a new communication system was introduced which allows crew members to talk to each other and anyone else in range of a loud speaker as well as to bases as far away as 2000 ft. Communication is two way.

What for 1960

Estimates are that bituminous coal production in 1960 will be about 430,000,000 tons. At this date such a forecast certainly seems reasonable. It is often forgotten that increases in markets for power stations, coke ovens and other consumers does not mean the same percent increase for coal consumption because they also are improving their efficiencies and doing more with a pound of coal than they used to. For example, projected yearly increase in steel capacity probably means no increase in coking coal needs because of improvement in coke rates and other efficiency.

There is no doubt the coal industry will continue its improved efficiency and productivity and if the marketing picture can be helped by lower transportation costs, less burning of oil and gas, 1960 should start the coal industry up the road to a healthier climate that practically everyone says lies in the future.

Bituminous Coal Economics

Needed — a National Fuels Policy for the most efficient use of fuel energy resources

By WALTER F. SCHULTEN
Vice President
Consolidation Coal Co.

With his broad background and keen insight to the coal industry's problems, Walter F. Schulten is able to present an outstanding analysis of "Bituminous Coal Economics." His early experience was with Illinois Steel Co., Universal Portland Cement Co. and Commonwealth Edison Co. He became associated with Pittsburgh Coal Co., Division of Consolidation Coal Co., in 1940, as general traffic manager and rapidly rose through the ranks to become vice president of the parent company in 1951.

THE coal industry is today and will be in the years to come, our fundamental source of energy. In the event of war, it will be called upon —just as other basic minerals will be called upon—to produce a good deal more, and very quickly. The country must look upon coal in relation to the contribution it would be expected to make during a period of national emergency.

From another angle, the country must regard the coal industry from the standpoint of the effective utilization of our energy resources. For we must not forget that the prospect of a fearsome general war is only one aspect of the global struggle which is going on today.

For the first time, the Soviet coal industry, if Russian figures can be accepted, produced a total of 545,000,000 tons in 1958. This is an increased use of coal by Russia, and it represents a hard-headed appraisal by them of the valuable use that can be made of coal to increase their industrial productivity.

Coal Is The Most Dependable Energy Source

The important question is whether the coal industry will be in position to meet the fuel requirements which war may bring.

During the hearings by the Office of Civil and Defense Mobilization on the application for restrictions upon the imports of petroleum, including residual oil, statistics were presented which indicated that the production capacity of the coal industry today must be maintained at a minimum level of at least 500,000,000 tons. Other data were presented which indicated that, in the event of a general war, the demands for additional coal production probably would be over 100,000,000 tons annually above the 500,000,000 ton level. This estimate probably is very conservative. The industry can meet this challenge under a reasonable and enlightened National Fuels Policy.

Experiences in the last war demonstrated the United States cannot depend upon foreign fuel sources.

In 1941, the year the United States went into World War II, it was importing 428,000,000 bbls of petroleum products. The next year submarine activity and other factors reduced imports to 307,000,000 bbls, a loss of 121,000,000 bbls. As the war continued, enemy action and the demands of our Allies reduced oil imports still further. Most of the loss was made up by coal. Coal production totaled about 461,000,000 tons in 1940; approximately 619,000,000 tons in 1944; the last full year of the war. Thus it can be seen that coal met the challenge in that emergency.

National Fuels Policy Needed

It is apparent that the national security requires a bituminous coal industry whose annual productivity is 100,000,000 tons or more above the 1958 capacity. What is the coal industry doing about this?

Last February, the coal operators, the United Mine Workers of America, the coal-carrying railroads, companies manufacturing coal equipment, and utilities burning coal formed the National Coal Policy Conference to promote the interests of bituminous coal. All these groups have a direct interest in coal. The producers and United Mine Workers produce it with the help of machines made by the equipment industry. Railroads haul it, coal being their best customer. The utilities consume it.

One of the first proposals of the Conference was that the Government draft and put into execution a National Fuels Policy; that is, a policy for the most efficient use of our fuel energy resources—coal, oil, gas, and atomic energy. There now are pending in both houses of Congress resolutions calling for establishment of a joint Congressional committee which would, after an appropriate inquiry, make investigations looking toward such a policy. The idea is not new. From time to time it has been recommended by private and public organizations since the early days of the Roosevelt Administration. Nobody ever got around to doing anything about it.

Coal's interest in this fuels policy is clear once the facts are examined. It is the position of the bituminous industry that some of the competition which has cut into the coal market sharply in the last 20 years constitutes a wasteful use of natural resources.

Competition For Fuel Markets

Some of coal's market loss is due to circumstances for which there apparently is no remedy. For example, railroads used around 125,000,000 tons of coal in locomotive engines

(*Continued on page 56*)

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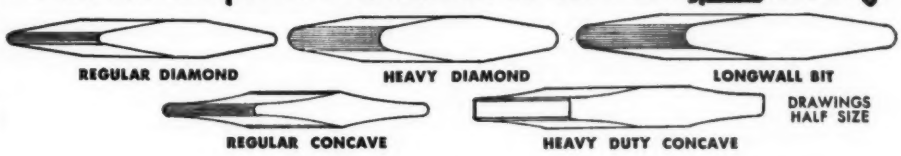

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UNDERGROUND MINING

Significant advances made in shaft sinking and raising techniques during 1959

By E. R. BORCHERDT
Borcherdt & Smith
Mining Consultants

THE year 1959 was not a particularly happy one for the mining industry which, with depressed metal prices and serious labor troubles, was perhaps reflected in comparatively few important developments in either equipment or methods in underground mining practices in the United States.

However, in foreign underground operations tremendously important advances have been made in two opposite fields of development—shaft sinking and raising. In the former, the long-sought-after record of sinking more than 1000 ft of shaft in one calendar month was made in Anglo-American's President Steyn shaft during the month of November 1959, when this 26 ft finished diameter shaft was advanced 1001 ft. The use of 10-ton sinking buckets, or kibbles, the largest yet used, was no doubt a factor in making this record possible. Great credit is due our South African friends for the long, thorough step-by-step development of shaft sinking with the Galloway stage and its auxiliary equipment.

Recent Advances in Raising

For many years raising was accepted as a strenuous and slow process, and little effort was applied to improve it. Within the past three years, substantial improvement in the efficiency of raising was made by the introduction of the so-called cage raising method. Not only was the rate of advance materially increased, but also, more importantly, the practical height to which raises could be driven was very greatly increased.

During the past year a mechanical raise machine, called the Alimak raise climber, was developed and manufactured in Sweden; it has shown great promise in improving advances over the cage raise system. It is essentially a platform cage which moves vertically, or at any inclination, on a sectionalized guide track anchored to the walls of the raise by rock bolts. A rack is incorporated in the guide track as well as air and water lines for operation of stoper type drills. An air motor, driving a pinion which engages the rack, raises and lowers the platform by compressed air supplied through a hose and reel.

The cycle in its simplest form is as follows: the miner raises the platform to the face of the raise, drills and loads the round and returns the platform to the sill level; here it is swung out of the raise into an excavation, which protects it from blasted rock falling to the sill. Air and water passing through the pipelines within the sectionalized track rapidly clear the raise of smoke and gas. The platform is then swung back to the track in the raise, and power is applied to raise the miner and his tools to the top of the raise while he is standing under a protective steel cover. After barring down or scaling, another round is drilled and the cycle repeated. One man can thus drill and blast several rounds each shift where ground conditions permit substitution of timber with rock bolts or in which small section raw raises are practical. Raise costs are in many cases reduced by half and the practical height to which raises may be driven is extended to 400 ft or more. The author inspected Alimak installations in Sweden and in Finland last summer and saw one of the original machines still in service and in good order after advancing thousands of feet of raise.

E. R. Borcherdt, an engineer of mines graduate of Michigan College of Mining and Technology, joined Anaconda in 1920 as an assistant geologist. He gained experience later as a miner, then as an underground engineer. In 1928, he became mines research engineer and ten years later chief research engineer. From 1954 to 1959, Borcherdt was director of mining research. He retired last year to become a mining consultant.

200 ft to 300 ft Level Interval Possible With New Technique

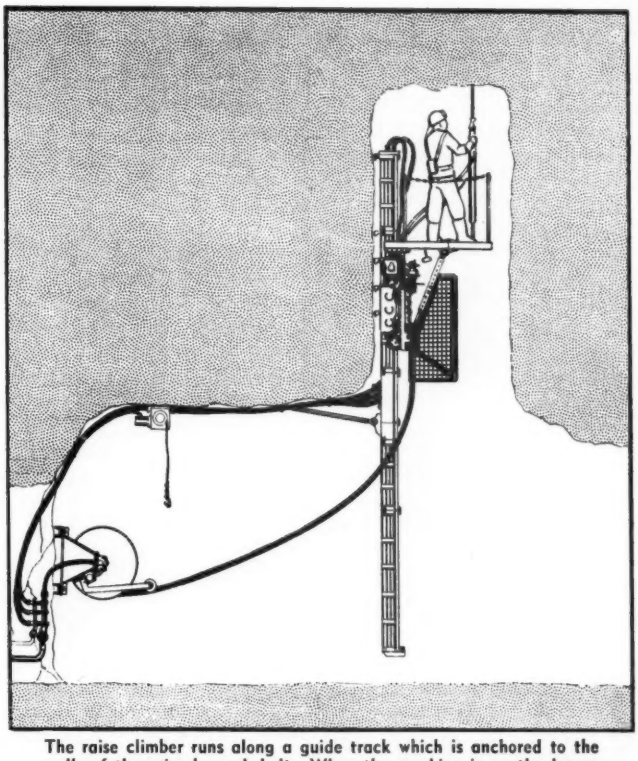
Improvements in raising technique should have a far-reaching effect in lowering over-all mining costs. The height of a mining block is a function of the practical height which a raise can be quickly and cheaply driven. This height, in turn, directly governs the level intervals, and with former conventional raising methods level intervals of 100 to 150 ft were maximum. However, the methods now available make the driving of 200 to 300 ft raises practical, thus doubling the possible level interval. This, of course, reduces the development cost chargeable to the mining of a ton of ore by one-half.

Without constant efforts to improve mining practices, the profit margin in the mining of low grade ores would become so small that mining companies would be forced to turn to foreign sources of higher grade ores. This would depress the domestic mining industry in much the same manner as has occurred in U. S. lead-zinc operations during the past two years.

Five and Six In. Drifters Being Used in Large Headings

In driving tunnels and large development headings, the practice of using

DEVELOPMENTS



The raise climber runs along a guide track which is anchored to the walls of the raise by rock bolts. When the machine is on the lower-hinged section, it can be swung out of the raise to protect it from falling rock

a five in. or six in. drifter drill to put in a few holes of four in. or six in. diam for burn cuts to extend the depth of the rounds has increased very greatly in the past year. Jumbo controls were further perfected to make it possible for one man to operate two or four drills simultaneously from a central position.

Recently important developments, in the application of a tunnel driving machine in which rotary tri-cone bits provide the cutting means, have been made in boring tunnels in fairly hard rock.

During the year further improvements in alternating current motor design made the replacement of direct current motors practicable. This occurred in both hoist and large electric locomotive installations. Almost without exception new hoisting installations were of the multiple rope, friction type machine. Primary hoisting from 7000 ft depths is planned in African gold mines, which should have an important effect in reducing over-all hoisting costs.

A non-destructive method of testing hoisting ropes, which has been under intensive development in Africa for the past several years, has been perfected, and was installed in a number of important hoisting plants in South Africa during 1959.

Improved drop-bottom cars, which were introduced during the year, are of new design with overlapping ends that permit continuous loading from chutes without stopping and without spillage between cars. Additional experimental work in applying overshot loaders in cut and fill stopes has been encouraging, and the use of the Wagner front-end loader in southwestern uranium mines has been successfully instituted during the year.

Successful application of the Transloader in stoping operations in the newly-developed Tennessee zinc mines has been recently made. Eimco 630 loaders have carved a place for themselves in the rapid sinking of medium-sized shafts in South African gold mines.

Hydraulic Shaft-Sinking Machine for Small Shafts

Alimak Corp. recently announced the development of a hydraulic shaft-sinking machine for small shafts, which advances down the shaft on guides bolted to the shaft walls and is motivated in much the same manner as the raise machine. A very logical development of this equipment is the use of a cactus grab, which is believed to be superior to the conventional clamshell.

Improvement in drill steel and bits has been in quality rather than in any particular design changes during 1959. Better brazing has resulted in fewer premature failures of carbide bits and the use of carburized rods has increased the effective life of the rod before breakage. As previously noted, increased use of large diameter carbide bits occurred in tunnel driving, and also the maximum size of carbide bits adapted to down-the-hole drills was increased to nine in. recently. Increased use of sucker-type bits was also noted.

The use of Imatrex in Sweden and Finland was recently observed. This is pure chlorate cast in stick form, which is in itself not an explosive until it is activated for blasting by impregnation with diesel fuel oil. Its use has been discouraged in this country by explosives manufacturers and by the U. S. Bureau of Mines, but experience of foreign users has convinced them that its use is no more hazardous than that of conventional explosives.

While not strictly regarded as an underground development, it might be noted that the installation of two centrifugal compressors of 43,000 cfm capacity will be completed shortly after the settlement of the present strike in Butte. These machines have many advantages over reciprocating machines in both cost of installation and of maintenance.

The effectiveness of yieldable arches in supporting extremely heavy faulted areas was demonstrated during the year in the Silver Mountain crosscut of the Hecla Mining Co.

Significant progress was made toward improving quality and increasing recovery with over-all reductions in cost

By EUGENE R. PALOWITCH
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Mining and Preparation Section
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COAL PREPARATION—1959

PRODUCTION figures for 1959 are not yet available from the U. S. Bureau of Mines but preliminary estimates from some of the leading coal-producing states indicate that the total production last year will be about the same as for 1958. The loss in metallurgical coal production because of the steel strike is expected to be offset by the general increase in business activity. The percentage of coal mechanically cleaned will be about 65 percent of the total coal production.

Several large new plants and many smaller plants and plant additions began operating in 1959. The emphasis was on total cleaning and several instalations included three different processes for washing the large, intermediate and fine-sized coal. New and expanded fine coal cleaning facilities included widespread use of the concentrating table, the introduction of the dense-medium cyclone washer and a marked increase in the use of froth flotation; concurrent emphasis was on dewatering and thermal drying of washed coals as a final step in total preparation. Taken as a whole, the coal industry made significant progress toward improving quality and increasing recovery with over-all reductions in cost.

Raw Coal Preparation

Raw coal preparation has as its function the preparation of a continuous and uniform feed to the cleaning plant. This coal should be of a top size suited to the physical characteristics of the coal and type of cleaning facilities, and be free of extraneous material. Facilities for raw coal preparation range from simple stationary grizzlies to complex mine- and railroad-car dumping and handling equipment, surge and blending bins, scalping screens, primary crushers, tramp iron magnets and conveyors.

The past year continued the trend toward larger capacity storage facilities between the mine and the preparation plant to lessen fluctuations in the quality and quantity of the raw coal output and thus provided a more continuous and uniform feed to the washing plant. Surge capacity up to several hours of mine output has made the mine and preparation plant substantially independent of each other. In some plants sufficient storage capacity is available in mine cars, bins, silos, or outside storage to permit one-shift operation of the mine with multishift operation of the cleaning plant. Newer installations favored single or multicell bins layer-loaded by a traveling tripper belt conveyor and equipped with vibrating or conveyor feeders for regulated discharge.

Size Reduction

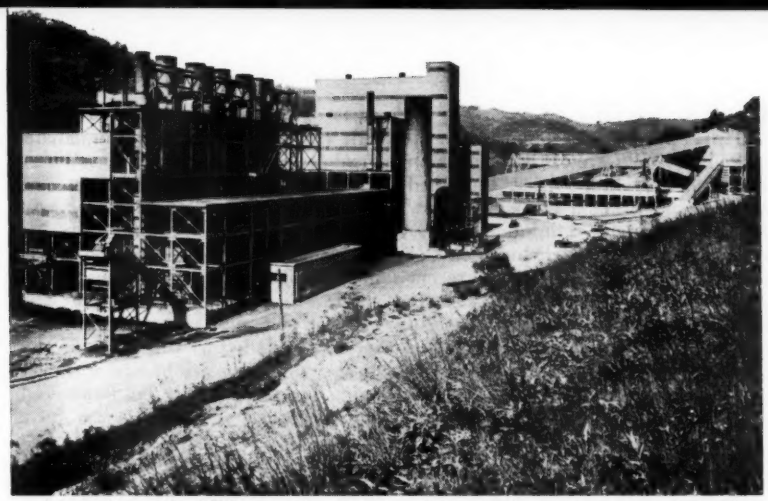
Amount of crushing done in preparation plants continues to increase. Crushing is done to reduce the top size of run-of-mine coal to suit the type of cleaning equipment available in the preparation plant, to liberate impurities in laminated coals and to crush cleaned coal to meet consumer requirements. Over 35 percent of the total output of bituminous and lignite coal in the United States was crushed for one purpose or another last year.

The rotary breaker for primary crushing and oversize scalping continues to be popular. Rugged stationary and vibrating grizzlies capable of handling high tonnages are being used in many of the larger plants for the removal of the very large reject that sometimes accompanies mechanically mined coal. Heavily constructed single-roll crushers capable of large reduction ratios are being increasingly employed for the size reduction of coals and rejects. Today's consumers not only specify maximum and/or minimum sizes but also specify maximum and/or minimum amounts of specific size groups within the size consist itself. This has prompted equipment manufacturers to develop new equipment capable of making the desired size reduction with minimum amounts of extremely fine coal. Some of the newer machines include slow-speed hammer mills, triple-roll crushers incorporating the advantages of both the single and double-roll crusher, and a two-stage double-roll crusher. A pulverizer capable of crushing run-of-mine coal to minus eight-mesh at 600 tph for producing pulverized fuel for cyclone-type burners in steam generation plants is in operation; a 28-ft-wide machine rated at 1000 tph is under consideration.

Eugene R. Palowitch joined the U. S. Bureau of Mines in Pittsburgh, Pa., as a mining engineer following his graduation from the University of Pittsburgh. His first assignment was prospecting and sampling coals in Pennsylvania, West Virignia, and Kentucky in connection with the Bureau's study of the washability characteristics of coals. He was later transferred to Bruceton, Pa., where he worked on a variety of coal preparation problems. In 1954 he joined West Virginia University as assistant professor of mining engineering, but rejoined the Bureau in 1957 as associate chief of the Mining and Preparation Section.

Sizing

Sizing is a very important phase of coal preparation. Raw coal sizing usually involves the removal of oversize too large for mechanical cleaning, hand picking, size reduction, or disposal. Depending on the washing process or processes, it may be necessary to make one or more additional size divisions before cleaning. Washed



Automation at this 1200 tph coal preparation plant extends even to the use of closed circuit television to keep a constant check on certain of the plant's processing equipment

coal is usually screened into various sizes depending on the consumer's requirements.

The rotary screen and shaking screen continue to be rugged high-capacity units for primary screening. Over the past several years the trend has been toward large high-capacity vibrating screens for separating raw plant feed into coarse and fine feed for the washers. Screen sizes 8 ft wide by 20 ft long are in use. Air spring supports for vibrating screen mountings to reduce noise and the transmission of vibration to the supporting structure were introduced last year. A sonic screen recently introduced in the coal industry has shown promising results for screening dry fine coal. Installations and new applications of the Dutch State Mines sieve-bend continued to increase last year as a result of greater emphasis on fine coal sizing.

Cleaning

Most of the preparation plants built in 1959 were either jigs washing the total size range or combination plants using dense medium for cleaning the coarse coal and concentrating tables for cleaning the fines. Of particular interest was the number of flotation plants installed last year. While the total capacity of flotation plants is relatively small, the important point is industry's recognition of the need for precise total cleaning and the acceptance of the principle of three distinct processes to wash the coarse, intermediate and fine coals. This practice is followed in Europe where economic conditions have justified total cleaning. Because the coal consumer will most likely continue to demand a high-quality product despite the difficulty of preparing coal produced under highly mechanized methods and deposited under unfavorable geological conditions, the Bureau of Mines anticipates that this trend toward total cleaning will be accelerated.

The jig dominates resultant coal cleaning where the raw coal feed to the plant is washed in a single unit after crushing or removal of oversize. Jig plants installed last year ranged in capacity from about 1000 tph and employed one or two very large jigs to small package plants of about 50 tph. About one-half of all the bituminous coal cleaned last year was cleaned by jigs. Except for severe washing problems, the jig offers a single high capacity unit capable of washing sizes from 0 to eight in.

Majority of plants installed last year for cleaning coal coarser than ¼ in. were dense-medium plants using either sand or magnetite water suspensions as the separating mediums. Trends in dense-medium plants using magnetite are toward shallow bath tank-type washers, dual gravity separators, and simplified flowsheets with minimum equipment. Dense-medium plants beginning operation last year ranged from multiunit plants capable of washing about 1000 tph to small package plants of about 50 tph.

The concentrating table dominated new cleaning facilities for the cleaning of unsized and deslimed fine coal. Practically all the new plants where dense-medium coarse coal washers were installed included concentrating tables for washing the fines. Of the table plants installed, almost all were the recently developed double-deck suspended table that doubled capacity per unit area and eliminated the necessity of heavy foundations. Improved efficiency was noted in several of the recently installed fine coal jig plants as a result of operating experience and improved controls.

The dense-medium cyclone washer made its debut in the United States late in 1959. Last year at least one plant began operation and several more were either being designed or under construction. The present application is for washing an intermediate size ranging from ⅜-in. to 48-mesh; studies are being made to expand the size range presently being treated by cyclone washers.

Flotation for cleaning coals finer than about 28-mesh advanced considerably in 1959 with installations totaling in excess of 500 tph of capacity. The factors behind this wider acceptance was the availability of improved flotation equipment and the introduction of simplified flowsheets that eliminated thickening and conditioning ahead of the flotation cells. Most installations last year used dilute plant water at rates up to 10,000 gpm and containing about five percent solids as the flotation feed. Other contributing factors favoring greater use of flotation was the increased production of very fine coal by modern mining, the necessity for recovering all salable coal of all sizes, and the need for plant water clarification and stream pollution abatement.

Mechanical Dewatering

Much activity was noted in removing surface moisture from coal by mechanical means.

Significant in the field of dewatering was the development of new dewatering screening equipment that employed high speed-low amplitude vibration, water-pool screens, and improved screen cloth for better dewatering and desliming. The Dutch State Mines sieve bend recently introduced in the preparation plant found many new and various applications. Manufacturers of centrifugal equipment continued their efforts to increase the water removal capacity and lower the maintenance costs on their machines. One of the most important new developments last year was the application of centrifuges for dewatering stoker sized coal. One plant in West Virginia is producing a centrifugally dewatered stoker product containing less than four percent moisture. Large diameter cyclones operated at low pressures were used for new applications such as classification, desliming and thickening dilute slurries before washing or filtering and for water clarification. Several of the new plants have installed drag tanks for dewatering fine refuse for easier handling. The vacuum filter was widely used for de-

watering cyclone and static thickener products and for dewatering the products from flotation plants.

Thermal Drying

Final elimination of water retained by the coal after mechanical dewatering processes continued to find wider application. More than 200 thermal driers were in operation last year in the coal industry drying coals as large as 1½ in. About 30,000,000 tons of coal were thermally dried in 1958 on screen, vertical tray and cascade, flash or suspension, fluidized bed, and Multi-louvre driers. At least three new thermal driers were introduced last year for drying both coarse and fine coal.

The bulk of the fine coal driers installed in 1958 were of the suspension or fluidized bed-type drier. Increased safety, high thermal efficiencies, low maintenance, and minimum degradation have done much to accelerate the use of thermal driers in recent years. The Bureau of Mines expects that the percentage of coal thermally dried will parallel the growth of fine coal cleaning facilities.

Water Clarification

Water clarification is a perennial problem requiring costly equipment to recover solids from the waste water. Coal operators are faced with rising costs of total solids recovery on one side and by stream pollution abatement legislation on the other. Where the suspended solids contain salable coal, all or at least part of the cost of water clarification can be recovered by installing suitable fine coal cleaning facilities; where the suspended solids are of little or no value, the black water may be pumped to a settling pond for disposal, or by means of flocculation, static thickening, and filtration, be dewatered and discarded with the plant refuse.

Acknowledgments

The author acknowledges the help of the many operators and manufacturers who have generously provided the information for this review.

BITUMINOUS COAL ECONOMICS
(*Continued from page 50*)

prior to World War II. The railroads bought less than 4,000,000 tons last year and will use even less in 1959. They are using diesel oil in their locomotives.

The household market has been diminishing steadily, also. Retail deliveries of coal have declined over 50,000,000 tons in the last 15 years. In 1946, nearly 100,000,000 tons were handled through retail yards; by 1958, the total had dropped to approximately 44,000,000.

Coal's complaints do not center about the loss of these markets, because this is in the normal course of free competitive enterprise. Coal does believe it has a legitimate complaint with respect to some aspects of fuel competition. It further believes that policies and practices which hurt the coal industry could be corrected by a sound National Fuels Policy.

The President, last February, found that national defense and security required the imposition of quotas on imports of petroleum, including residual oil. The curtailment of petroleum imports came after a petition filed with the Office of Civil and Defense Mobilization alleging they threatened national security. The Government evidently felt that petroleum imports, including residual, did impair the national defense.

This curb on petroleum imports constitutes a very strong indorsement, indirectly, of coal's claim that its production capacity is important to national defense and security.

In the case of natural gas, coal has to meet competition from an industry enjoying unwarranted benefits by reason of the present natural gas act. The gas companies apparently can, with impunity, load disproportionate costs of the line upon residential consumers for the specific purpose of capturing markets with an unreasonably low rate.

Investigations Needed in Interest of National Security

An example of this practice is seen in the dissent of FPC Commissioner Arthur Kline in the case of Tennessee Gas Transmission Co., which, through its subsidiary the Midwest Gas Transmission Co., applied for authority to enter the Chicago market—authority which was granted.

In his dissent, Commissioner Kline said low-cost sales to "the steel companies and electric utilities" in the Chicago area would be at the expense of residential and other consumers of gas who had firm contracts. Actually, the price charged the utilities and heavy industry, in many instances, was less than the price Midwest paid Tennessee Gas for the product.

An investigation looking towards a National Fuels Policy, theoretically, would throw light on coal's assertions that it is the victim of unfair competition, which in turn threatens national security.

The investigation would throw light not only upon coal, oil and gas, but also upon the anticipated impact of atomic energy upon the over-all fuels picture—and its proper place in this picture.

To illustrate, the chairman of the Atomic Energy Commission, John A. McCone recently said that it was "quite significant" that the Russian leader, Koslov, had told Admiral Rickover "That they (the Russians) had been badly misled by their scientists on the cost of nuclear power, and therefore they were not proceeding with it as a program. . . . They have found that nuclear power was much costlier than they expected. *Thefore, they are meeting their growing power demands by conventional means using coal.*"

Many experts predict a bright future for coal. However, this will come to pass only if an enlightened fuel policy is adopted. Meanwhile the coal industry will make every effort to help itself by developing new uses for coal and continuing to improve productivity.

Coal has an enviable record for productivity and general price stability. It is an interesting fact that in 1948 coal was $4.99 at the mine; today it is around $5.00, representing an increase of only one cent a ton in an 11-year period. Therefore, it cannot be said that the producers of coal are pricing themselves out of the market.

We need a National Fuels Policy. Moreover, the writer suspects that we need a National Minerals Policy as well. In any event there must be a careful examination of the facts today and action in accordance with the best over-all interests of the nation.

Obviously, such an examination should be objective, non-partisan, and impartial. All viewpoints should be given equal opportunity for expression. The results should mean freer competition with no special advantages to any fuel, but with benefits to all elements of the nation's economy. It should mean conservation of our exhaustible natural resources in the interest of national security. It should mean the achievement of a balanced fuel economy in order to meet the challenge of our expanding fuel markets and at the same time provide fuel insurance in the event of war.

Trends in Open Pit Mining

By C. E. McMANUS
General Manager
Hollinger-Hanna Ltd.

In 1959, despite the fact that major U. S. open pit iron ore operations were closed down for 116 days, and copper for about four months, operating and technical advances in these fields continued. Open pit mining has grown rapidly over the past few years as development of more efficient equipment and techniques has permitted increasing stripping ratios. The writer covers the trends in this field during 1959.

C. E. McManus' mining career began 27 years ago with Butler Brothers at Cooley, Minn., where he was employed as a mining engineer following graduation from the University of Minnesota School of Mines. From 1933 to 1945 he served in various capacities including chief engineer and assistant manager of both underground and open pit operations. He was M. A. Hanna Company's superintendent at the Clifton mine near DeGrasse, N. Y., during 1946 and 1947, and from 1948 to 1951 he served as the company's assistant manager of Minnesota mines. McManus became project manager for the Quebec-Labrador development of Iron Ore Company of Canada in 1952 and was subsequently appointed general manager.

IN the transportation field the trend has definitely been to larger and more powerful units. Stock haulage trucks of approximately 35-ton capacity have been increased to 40 and 50 tons, and higher.

One unique development is a massive 18-wheel end-dump truck that is hauling approximately 70 yd, although it has a theoretical capacity of 110 cu yd.

Electric Wheel Trucks

Considerable interest has been expressed in designs using the electric wheel. One company is awaiting delivery of a unit powered by four motor wheels of 400 hp. This is an articulated unit measuring 42 ft in length, which will carry a 60-ton payload. Empty weight is 55 tons. The unit is designed to operate from a trolley during the haulage cycle, but is equipped with an auxiliary diesel engine for maneuvering around the shovel and the dump, after it has been disconnected from the trolley line.

Another development in this field is an eight-wheel truck-trailer combination utilizing diesel power for primary generation of electric power which is delivered to the four electric driving wheels, two on the truck and two on the trailer. A prototype, now being constructed and to be delivered early in 1960, will be powered by a 700-hp diesel unit.

Gross vehicle weight of the truck is 150 tons with a 90-ton payload; gross vehicle weight of the trailer is also 150 tons, with a payload of 96 tons. Tires are 44.5 by 45. This unit is primarily designed for a level or downhill haul.

Braking is one great advantage of the electric design because braking effort is not related to engine horsepower, and the four wheels can produce 1600 hp continuous braking.

Tire loading is the most critical problem, the other components being in the main standard locomotive equipment which have been proven in practice.

The electric wheel principle has also been applied to scrapers. One model is powered by two 600-hp diesel engines directly connected to d-c and a-c generators. These units have a capacity of 130 tons.

One manufacturer developed a truck, available from 22 to 32-ton capacity, which has eliminated the use of springs through a nitrogen hydraulic suspension system. It is claimed that this device cushions against loading and travel shock, reduces maintenance cost, eliminates the front axle and compensates for off-center loads. This principle has also been applied to rubber-tired scrapers.

On a South American operation, heavy-duty trucks are hauling downhill approximately 34 miles. One unique feature of this operation is the use of sand pits at intervals on the downgrade section to permit the truck to be stopped safely in the event of brake failure.

Trend To Larger Tractors

Among track-type tractors the trend has been to increase both weight and size of equipment and horsepower. One item which greatly increases workability and eases the work of the operator is the introduction of the powershift transmission.

One of the more recent developments in the heavy tractor attachment field is the use of the hydraulically controlled, tractor-mounted ripper. The design of the ripper, together with the heavier and more

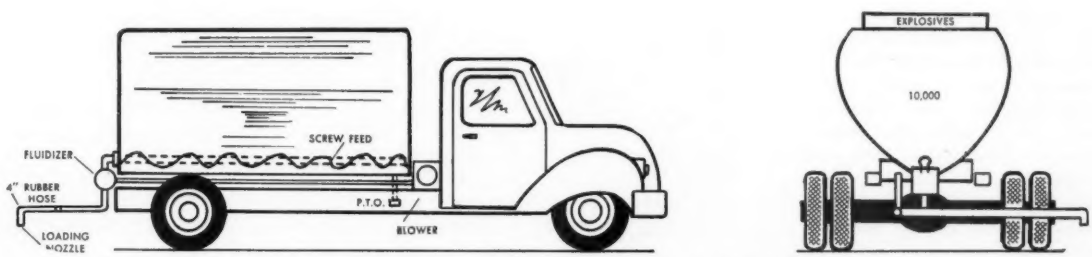


Fig. 1. Diagrammatic sketch of ammonium nitrate loading truck

Iron ore on its way to market

powerful units, has increased the scope of successful scraper operation. The combination has worked very successfully in frozen overburden, iron ore, hard pan and certain types of rock, effecting a considerable saving over the conventional method of drilling, blasting and loading out by shovel and truck.

A new seismograph method has been developed which helps to determine the various overburden or rock strata, and will also give an indication of rock density and hardness. The system is being applied to determine the feasibility of scraper loading with the use of heavy-duty rippers.

Scrapers and graders have also followed the trend toward larger capacity, heavier and more powerful units.

Loading Units and Techniques Improved

Among the various loading devices shovels continue to be the mainstay of open pit operations. Use of special alloy steels has in some cases permitted an increase in bucket capacity without increasing the over-all weight of bucket and load. Increased pressure for the mining operator to maintain a uniform blend, which in most cases calls for more selective mining, requires more frequent moving of the shovel from face to face. This becomes a major problem with larger equipment. To avoid the capital expense of standby equipment, considerable interest has been exhibited in methods by which shovels can be moved more rapidly. For some time and to an increasing degree, portable generators have been utilized. One mining company solved this problem by using two heavy-duty floats, placed side by side, one centered under each track.

Use of rotary drills and down-the-hole percussion type drills continues to increase at the expense of the churn drill. Bits for both rotary and percussion rigs have been improved. Rotary drills, in particular, are finding application in harder and harder formations, which could not be handled a few years ago.

In pits that have ground water problems, the churn drill is still the accepted tool for drilling larger diameter dewatering well holes.

Blasting Procedure

While the use of ammonium nitrate base blasting agents is well known to the industry, and all indications point to increased application, several developments have taken place which should increase the efficiency and further lower costs.

To improve upon the currently fashionable procedure of field mixing AN-FO by manual methods, several operators, in an endeavor to ensure uniform mixtures and reduce handling costs, have developed mechanical methods of handling the mixture.

At one operation a 3½-ton stake-body truck is used as the basic machine for transporting, mixing and loading. A small air compressor was mounted on the front and a 150-gal fuel oil tank on the side. At the rear of the truck platform an aluminum hopper was mounted in such a manner that an adjustable loading spout would clear the end of the truck. The lower end of this hopper houses an electrically-operated gate which controls the flow of AN and automatically sprays fuel. This operator reports a reduction in the size of the blasting crew from 11 men to 5 men. At the present time, a loading crew consists of a truck driver, two men on the truck platform to place the sacks into the hopper and two men on the ground to place primers, handle Primacord and backfill the holes.

At another operation, AN in bags, or more recently in bulk quantities, is being mixed with fuel oil in a mixing plant and transported to the blasting site in loading trucks, somewhat similar in principle to the familiar ready-mix concrete equipment (See Figure 1). The transporting truck is licensed for 10,000 lb of AN-FO.

All power for the loading operation is furnished by a transmission power take-off which drives the feed-screw, blower and fluidizer star valve. The explosive mixture is metered and delivered through a 4 in lightweight rubber hose 100 ft long. This unit delivers 350 lb per minute and requires the services of only two men; the blaster, to determine the amount of charge to each borehole, and the truck driver, to operate the fluidizer unit. This system eliminates the handling of AN bags in the pit, the clutter and hazards of loose materials on the bench, and ensures the rapid delivery of an accurately compounded and thoroughly mixed explosive. Prior to the delivery of the AN mixture, the hole is prepared by suspending in it a five-oz pentolite primer on Primacord. This loading system has proven very successful and has effected a considerable saving in labor cost.

Experimental Work Still Going On

AN-FO mixtures have two basic shortcomings:

1) **In wet holes the material must be packaged in water-resistant bags. Due to its low density (0.8), it is difficult to force the AN package to the bottom of holes containing considerable depths of water. Also, trouble is experienced in snagging the bags on rough edges.**
2) **In hard rock, because of its low density, straight AN–FO will not shatter the rock properly.**

To overcome these problems and still preserve the basic low cost of AN as an agent, a great deal of experimental work has been carried on by operators in the United States, Canada and Europe, with high-density slurry mixtures made up of AN and water and various other sensitizing ingredients such as molasses, TNT, sugar, sodium nitrate and powdered coal.

A Swedish operator is using a mix-

ture of potassium chlorate treated with kerosene or diesel oil for dry holes; for wet holes, a slurry made up of 72 percent sodium chlorate, 9 percent fuel oil, 2 percent carboxymethyl cellulose and 17 percent water.

These types of explosives have also been used in England and Belgium, but they are not approved by the U. S. Bureau of Mines.

At the moment, the most significant development seems to be the introduction of a slurry composed of a mixture of AN, TNT and water. Patents have recently been issued and the blasting agent can be obtained from commercial sources in the United States and Canada.

This mixture effects a water-compatible, high-density explosive, less sensitive than straight AN-FO mixtures, and it is one which can be economically handled.

The following table shows a comparison between the properties of AN-FO and the slurry mixture.

Composition	94/6 AN–FO	65/20/15 AN, TNT & Water
Density (grams/cc)	0.8	1.4
Critical diam (in.)	4	4
Minimum booster (grams tetryl)	40	80
Detonation rate (meters/sec)	2800	5500
Explosion pressure (kilobars)	18.5	59

One operator reports that in hard rock, with the use of slurry, spacing and burden could be increased to the point where 1.7 times more broken rock per foot of borehole was produced as compared to AN-FO, while at the same time fragmentation was improved.

Another development, hand-in-hand with the AN-base explosive, is the use of the cast pentolite primers or boosters. These, to a considerable extent, are replacing HE as a detonator for the insensitive open pit blasting agents.

Illustrating the extent of replacement of so-called standard explosives by AN mixtures, one operator reports as follows:

	High Explosives	Canned Blasting Agents	AN & Slurry	AN–FO
1957	22.5%	67.3%	0 %	10.2%
1958	5.9%	10.6%	1.6%	81.9%
1959	2.7%	3.4%	11.7%	82.2%

The following table indicates the percent of AN-type explosives used in all Canadian open pit mines, together with a manufacturer's estimate of Canadian usage in 1963.

	AN–TNT Slurry	AN–FO	Total
1958	5%	48%	53%
1959	17%	51%	68%
1963 — Estimated	26%	58%	84%

Cold Weather Operations

Inasmuch as a considerable number of open pit operations in North America are subject to rather severe winter conditions, it might be pertinent to discuss some of the attendant problems.

The decreased strength of ordinary steel at lower temperatures is well known to any operator who has suffered excessive breakdown during a cold snap. Some cures for this trouble include: making shovel booms of special steel and heating them with Calrod electric heaters, and heating the bearings on motor generator sets.

At one operation, a severe cold wave wiped out virtually all the trailing power cables due to cracking of the insulation. After several attempts power cable manufacturers, together with rubber companies, devised a cover containing a high percentage of natural rubber, which up to the time of the present writing, seems to retain the required flexibility at sub-zero temperatures.

Extensive use is made of infrared heating lamps to prevent build-up of frozen ore on conveyor pulleys.

A gas-fired infrared heating system was installed at one location to release frozen ore from railroad cars. While the system satisfactorily freed the ore, it did not entirely solve the problem of handling frozen ore, as quite often a 60 to 80-ton mass would release in one chunk, with resulting damage to structures below.

Any rail system operator in northern areas is probably well acquainted with the problem and expense of keeping switches free of snow. A recent innovation has been the utilization of an aircraft jet engine. The unit is mounted on a rail car with the blast directed down the track. One unit is being tested experimentally by a large eastern railroad, and from preliminary reports it has been successful in clearing the track of snow without leaving a melted residue.

Eight-cu yd shovel loading iron ore into 35-ton truck. In the background the old and the new—a rotary drill working alongside a churn drill

Automation

Closed-circuit TV, together with improved instrumentation, is being increasingly applied to permit an operator at a central control point to control all phases of an operation. It eliminates the necessity for guardians at transfer points, or other places where the principal function is watching the operation.

In one transfer bin operation, radio-active indicators have been installed; appropriate signals, which indicate the level of ore in the bin, automatically control the feed and output to maintain the level in the bin within predetermined limits. This has proven much more successful than previous mechanical type indicators.

Another tool for the operator's kit is the application of digital computers to the open pit operation. Medium-size computers are now available at prices starting at about $40,000. The

Drive-across crushing plant. The original flowsheet was simply a primary crusher which would take the material down to six in. Due to the increased demands of furnace operators for a sized product, secondary screening and crushing is being installed in the loading pocket in the background. This will permit production of sized two-in. material

computer is suitable to handle two types of problems: those which are repetitive, recording over and over again; and those which do not occur frequently, but are so complex as to make computer solution a necessity.

Many companies are making use of data processing machines and computers to perform clerical functions such as accounting, inventory control, reserve estimates, operating statistics, and so forth.

One company has been using computers to solve ore blending problems on a linear programming basis for almost a year, with good success.

A large iron ore company, which at the present time is making extensive use of conventional business machines for payroll application, accounting, accumulation of statistics and averaging of ore grades, has just completed a feasibility study which indicates that by introducing a computer, in addition to present equipment, the following items may be electronically handled:

Inventory Control

Current inventory, automatic reordering in economical quantities, reduction of inventory.

Engineering

Ore grading.

Determination of ore reserves.—Current updated ore reserve data would be available for each mine by ore type and by lift. Reserve calculations would be based on current geological and drilling information correlated with historical records.

Royalty calculations.—At present very time consuming.

Scheduling.—Development of grade and mining schedules for future years based on historical information accumulated in determination of ore reserves.

Dump locations.—Optimum location of dumps can be facilitated by utilizing operations research techniques. Use of established computer routines would enable alternate dump location studies which are currently too time consuming to be profitable.

Rail operations.—Data handling system would provide information as to optimum of grades, location of passing sidings and scheduling.

Photogrammetry Used in Volumetric Computations

Another use for the computer in the mining industry is the recent development concerning the use of photogrammetry as the basis for quantity determination for periodic and completion report purposes.

The system requires that a basic ground survey control system be established in the area on which periodic reporting of excavation or stockpiling is undertaken. A series of reference photographs, either aerial or terrestrial, is then taken to establish the base to which future operations are referred. The information provided from the initial set of photographs is registered on a punch tape. Other tapes are made up from sets of photographs subsequently taken at the required intervals of time for reporting purposes.

The two tapes are then processed in an electronic computer together with information concerning the type of material and physical specifications as to slope limits, berm or grade widths, if applicable, and the quantities in excavation borrow or stockpile are computed.

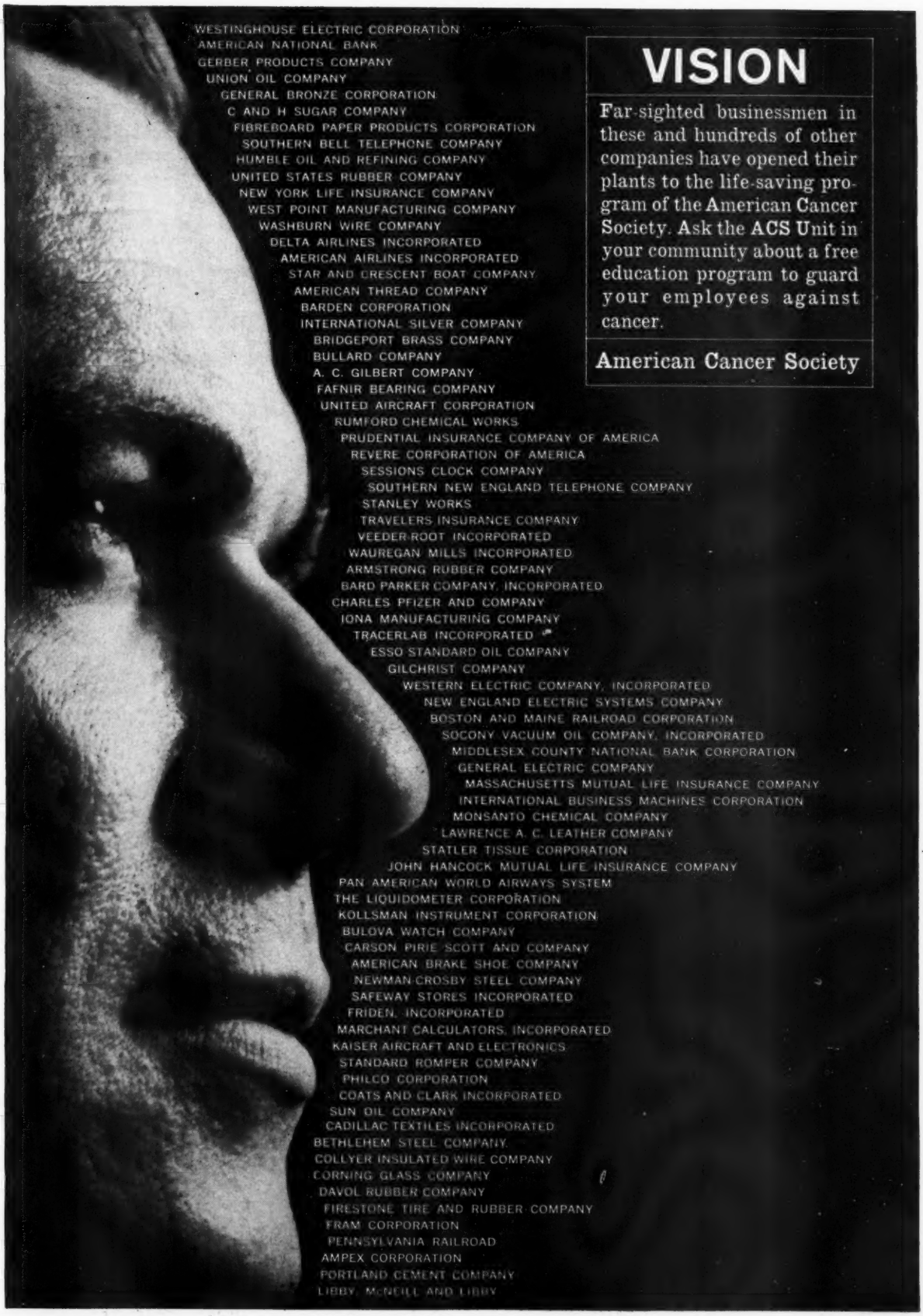
There are several advantages which the compilation of quantities by this method offers. These computations may be done faster and less expensively than by ground survey methods and a considerable saving of field engineering time is to be expected. Generally, the cross sections obtained photogrammetrically reflect the shape of the ground in a truer fashion than the usual ground survey methods do; and the possibility of human error in calculating volumes is considerably reduced through the use of stereoplotting instruments for obtaining the cross-section data, and the use of electronic equipment for the computation of volumes. In addition, photographs which are required provide a rapid, convenient and indisputable record which can always be available for reference.

The development of this technique is still new, but it appears that it will shortly be improved to the point where its use will become an accepted method for volumetric calculations.

Applied Soil Mechanics

Soil mechanics research is finding increasingly favorable application, as operators attempt to predetermine optimum costs and prevent costly and dangerous errors. In open pits this applies to slope of the bank and width of berms—as with the increasingly higher stripping ratios, overstripping or understripping can be extremely costly. An application of the science in northern climates, which has proven very successful, is the predetermination of frost-susceptible qualities of the sub-soil under the proposed routes of haulage roads or railroad grades; it is also used to determine the same information on all material proposed as fill. Costly delays and costly repair jobs have been incurred where frost-susceptible material has been allowed to remain in place or has been used as fill. In some cases, it has been necessary to excavate as much as six ft below subgrade and backfill with suitable material. It has been well demonstrated that studies of this nature pay off the careful operator.

In this period of spiralling labor costs, it behooves the operator to make use of all the modern tools at his command.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LEAD-ZINC

On the whole, 1959 closed with zinc showing signs of returning to a satisfactory price level for both domestic producers and foreign producers, but lead continued, in both markets, in a severely depressed state

By CHARLES E. SCHWAB
General Manager
Bunker Hill Co.

DURING 1959 the United States lead-zinc industry operated under the first full calendar year of the import quotas as established by the President's Proclamation, September 22, 1958. The record for 1959 leaves much to be desired from the domestic lead-zinc mining industry's viewpoint and substantial segments of the lead-zinc custom smelting industry continued their opposition against continuation of the quota plan. There was, however, a significant change in the position of some of the leading custom smelters when in August they stated publicly, for the first time, that they would accept an increase in duties in lieu of quotas. Previously many of these same concerns opposed any import controls whatsoever.

During the year the conditions of each metal varied and therefore each must be looked at separately.

U. S. Lead Production Continued to Decline

Notwithstanding the import controls, lead mine production continued to decline and, even crediting for minor mine production losses due to strikes, mine production of lead in the United States in 1959 will again set a new record low—about 15,000 tons less than the previously recorded low of 1958.

While there was some momentary improvement in the U. S. price during the fourth quarter of 1958 following the imposition of quotas, the U. S. price leveled off in the range of 11.5 to 12 cents. It was only concurrent with a strike which closed a substantial portion of the primary lead smelting industry that the price rose to 13 cents during the last half of 1959. At the conclusion of this strike, the price declined again to 12 cents. In general, after a year of quotas the domestic price continued at approximately the same level as prior to the quota imposition.

So far as world market prices (L.M.E.) are concerned, lead made no recovery whatsoever during the year and stayed in the range of £72, with a very minor recovery late in 1959 to about £74. Despite the "voluntary reduction" commitments announced at the third United Nations Lead-Zinc Meeting in New York in early April, production and consumption outside the United States left much to be desired for a balanced situation, and this was reflected on the L.M.E.

Consumption by all U. S. industry, except for cable covering, showed substantial improvement over 1958.

Under conditions prevailing in 1959, it can be said that lead continued to be rather severely depressed and that there was no significant improvement compared with 1958 from a mine producer's point of view. Stocks of refined lead in the hands of producers in the U. S. continued very high during the year. Notwithstanding the major primary lead smelting strike, the year closed with more than adequate lead metal stocks and the recent decline in stocks during the end of 1959 will undoubtedly cease.

Improved Picture for Zinc

In contrast to lead, zinc has made some improvements both inside and outside the U. S., as evidenced by a steady increase in L.M.E. price and a rather steady increase in domestic price. The world prices gained about 2.5 cents during the year and closed in 1959 at £94 to £96 (almost 12 cents). In the U. S., zinc moved also about 1½ cents from 11 cents at the opening of 1959, to 12.5 cents at the end of the year, and further advanced to 13 cents on January 8, 1960. A combination of much improved consumption both here and abroad, together with the announced "voluntary reductions" at the U.N. meeting in early April (at least this had a signifi-

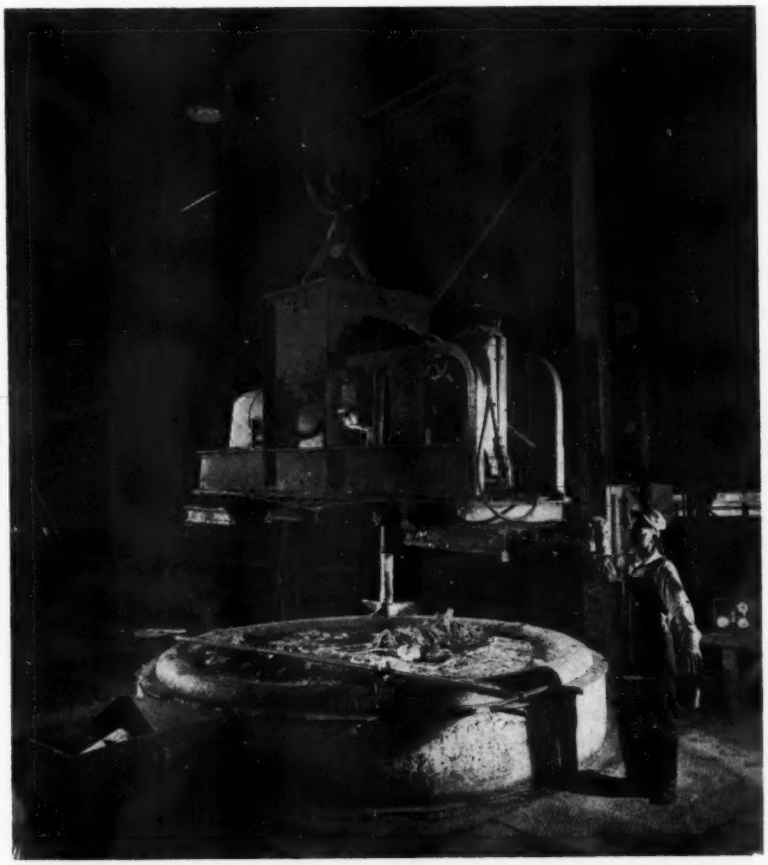
Domestic mine production of zinc is expected to show some continued improvement in 1960

There is no one in the lead-zinc industry more qualified to write this year's review than Charles E. Schwab. Until recently chairman of the Emergency Lead-Zinc Committee, the demands of that job required that he be especially well informed on industry developments.

Schwab graduated from Ohio State University as a mining engineer in 1936. He then went to work as an underground miner on Michigan's Gogebic Iron Range in the Lake Superior District and later worked as an exploration engineer for Basic Refractories, Inc., becoming manager of the Western Division in 1940. He joined Bunker Hill in 1944 as a mining engineer and by 1948, his work included industrial relations in addition to supervisory duties underground. He was later appointed manager of the Employee and Public Relations Division and in 1957 was made assistant to the president. Schwab was named general manager of the company's Kellogg operations in 1959.

cant psychological impact on the market), saw zinc at the end of 1959 in a much better over-all position than is true for lead. U. S. markets were disrupted during the year by major strikes of consumers (a 116 day steel strike) and also by substantial strikes in zinc mining and in zinc smelting plants. The combination of work stoppages, occurring at both the consuming level and the producing level tended to offset each other, but with the general improvement in consumption together with the import quotas, zinc ended the year 1959 in a fairly strong position. Despite all this, however, U. S. zinc mine production was only 43,000 tons above the 1958 level after crediting losses due to strikes. Some mine producers announced the opening of new zinc mines, or the reopening of some which had been closed down due to the depressed prices of the prior two years. It can be anticipated that domostic mine production of zinc in 1960 will show some continued improvement.

At the close of 1959, producers' stocks of slab zinc, while high for Prime Western, were again manageable for Special High Grade. With the resumption of work in some of the struck plants near the end of 1959, plus the announced increased production at other substantial producers of Special High Grade, adequate supplies of this quality of metal will be available to meet any liberal estimates of consumptive demands in the first quarter of 1960 and on forward during the year.



After a year of quotas the domestic price of lead was at approximately the same level as prior to the quota imposition

1959—A Year of Changes

The U. N. Lead-Zinc Committee is again meeting in Geneva beginning January 25, 1960 and it has been widely predicted that the "voluntary reductions" for zinc will be removed and that some formula will be sought to continue the "voluntary reductions" for lead, because of its continued depressed situation in the world market. Such a formula, however, will be somewhat difficult to evolve because of the conditions prevailing in many orebodies throughout the world whereby lead and zinc are both produced in the same operation.

Thus the year 1959 may be summarized as follows:

(1) Continued disappointment by the U. S. lead-zinc mining industry because the import quotas, in a 15-month period, have failed to return the industry to what it considers is required for soundness and stability insofar as U. S. prices and U. S. mine production are concerned.

(2) Continued opposition by substantial custom smelters to the import quota plan, and their recommendations that an increase in duties be imposed in lieu thereof.

(3) A marked difference in the two metals as lead continued in a depressed condition and zinc, while showing some improvement, still left much to be desired from the U. S. mine producer's point of view; and the condition at the end of the year, whereby both in London and in the United States the price of zinc exceeded that of lead for the first time in many years, except those prices prevailing when Government decree, such as ceiling prices, set zinc above lead.

(4) An improved consumption in the U. S. and in the world for both metals compared with 1958, but a much more significant improvement in the case of zinc.

(5) A significant event occurred at the U. N. April meeting when, for the first time, producers outside the United States committed themselves to "voluntary reductions in production, exports or sales" and now seek some arrangement to release zinc from its commitments at the January 1960 meeting, but continue the reduction commitments for lead.

It is doubtful that another year could be found with so many elements of change as 1959. This was the first full year of operating under the U. S. quota plan; major strikes occurred at U. S. producer and U. S. consumer levels; and the U. N. commitments were made. On the whole, 1959 closed with zinc showing signs of returning to a satisfactory price level for both producers inside the U. S. and outside the U. S., but lead continued, in both markets, in a very severely depressed status.

STRIP MINING of COAL

Many new concepts were introduced or definitely proven during 1959. Accent was on larger, more productive equipment

Improved methods and equipment are being employed to keep mining costs down and improve product quality

By ANDREW HYSLOP, JR.
Chief Engineer
Hanna Coal Co.
Division of Consolidation Coal Co.

STRIP mined coal, which accounts for some one-fourth of bituminous coal production, is faced with the problem of a constantly increasing higher ratio as reserves are depleted. Ratios in excess of 20 to 1 are being successfully worked with bank heights of over 100 ft. Interest in large excavation equipment is always high and the past year saw larger, more productive equipment put in operation in the strip mines, already famous for their spectacular excavating equipment. A shovel bucket large enough for two cars side by side has been put on a larger machine for increased operating range. A machine (Model 5761) of the comparative specifications given below was put in operation toward the end of the year and is operating quite satisfactorily.

Andrew Hyslop, Jr., is a well-known engineer in the coal industry. He began his career in underground mining as chief engineer for Walter Bledsoe Coal Co. and Sun Hill Coal Corp. at Terre Haute, Ind., and worked in this area for some 14 years.

In 1940 he joined Hanna Coal Co. in eastern Ohio as a deep mine superintendent. With the extensive expansion of Hanna into the coal stripping field, he was called on to work on the engineering problems of large stripping equipment. Over the past 14 years, he has been active in the design and development engineering of machinery for the stripping industry and holds a number of patents on machinery developments and in explosives.

Comparative data on the largest shovels in operation in 1958 (Model 5760) and the new shovel put in operation in 1959 (Model 5761)

Machine Model No.	5760	5761
Bucket capacity	65 yd	65 yd
Boom length	150 ft	170 ft
Dumping height max.	93 ft 6 in.	116 ft
Dumping radius max.	145 ft 6 in.	162 ft
Machine weight	5,500,000 lb	6,500,000 lb

With such machines, bank heights are increased and strip reserves are being expanded. Several top-size machines were put in operation during the year, and serious engineering is being done on machines 1½ and 2 times larger than the one shown. Bucket capacity of over 100 yds is being seriously considered and boom lengths up to 225 ft.

The high power requirements of such machines have created electric power transmission problems which have received attention during the year. Trailing cable potential of 7200 volts is being used on these large machines, and higher voltages are on the drawing boards.

Five Wheel Excavators Are Now in Use

After several years of experimental and development work by an operating company, the Kolbe wheel-type excavator has been put in the production line of a manufacturer. For overburden removal, the unit is being used quite extensively at operations where the soft overlying strata must be transported well back from the active pit area. Five of these machines are now in operation, and they have advanced from the original capacity of about 1000 cu yd per hr to some 3500 cu yd per hr. These machines are used in tandem with shovels which remove the harder materals which lie directly over the coal.

Progress Made in Sensitizing Ammonium Nitrate

With higher banks also come increased drilling and blasting problems. In many cases, this is the highest cost item of overburden removal, often exceeding that of operating the excavating machinery. The past year saw further expansion and advancement in the use of bulk ammonium nitrate "do it yourself" procedures with the coal stripping industry going very largely to this type of explosive due to its convenience, safety and cost. Many different methods are being used in the utilization of ammonium nitrate with a mixture of hydrocarbon, usually fuel oil, with most methods requiring an initiating explosive of higher speed and sensitivity to properly detonate the ammonium nitrate. However, progress is being made in sensitizing the ammonium

nitrate so that the addition of the costly booster charge will not be required. One company has been able to make a comparatively simple preparation of ammonium nitrate-oil mixture which shows much promise. It is cap sensitive and gives a consistently good detonation without the customary addition of boosters.

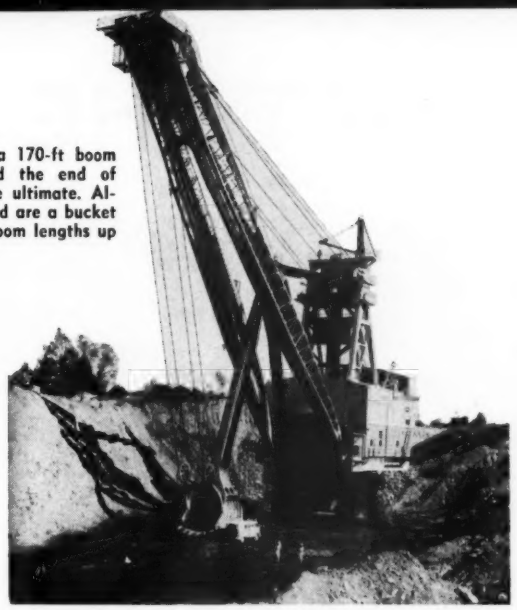
Drill Designed to Angle Holes Up to 30° Off the Vertical

Large diameter holes are usually considered advantageous with ammonium nitrate-oil explosives and, consequently, there has been progress in developing larger and more efficient drilling machines. These are largely rotary-type drills employing air to remove cuttings. Through the use of large, heavy machines it is usually possible to maintain the footage drilling rate with increased hole diameter, thus reducing the cost on a volumetric basis.

A high bank also presents problems in the drilling pattern. In horizontal drilling, the high bank creates the obvious and serious problem of drilling high holes, and in vertical drilling there is the problem of getting the drill well out on the edge of the highwall to prevent improperly blasted "toe" areas at the bottom of the bank. The possibility of angled vertical holes has been widely discussed, and one manufacturer now has a drill designed and ready for trial on angle holes up to 30° off the vertical. Several new features are incorporated in the machine which show promise of cost reduction in this important phase of high bank operation.

Work Done on "Electric Wheel" for Truck Use

The trend toward larger equipment and thus higher overburden means longer transportation hauls due to working greater reserves from one location. Hauling coal from the pit to the preparation plant, or rail loading facilities, is a major cost item in strip mining, and lengthening the haul quickly brings this item under scrutiny from a cost standpoint.



A huge 65-yd machine with a 170-ft boom was put in operation toward the end of 1959, but this will not be the ultimate. Already being seriously considered are a bucket capacity of over 100 yd and boom lengths up to 225 ft

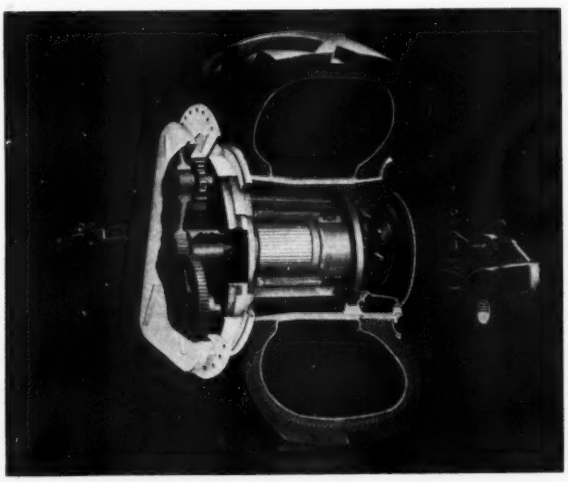
The past year saw an expansion in the use of 50 to 60-ton capacity trucks, and additional 80-ton units are being successfully used. Of course, it is relatively easy to build a truck with a large coal capacity; however, for efficient haulage, the truck components, such as engine, transmission, tires and axles, must be properly matched to get higher, more efficient haulage capacity with reasonable maintenance. Ton-miles per hour is a much better criterion of truck capacity than tons and, during 1959, there was considerable work done to up-rate these truck components. The result was an appreciable increase in ton-mile per hour capacity. Engines and transmission of 450 hp to a single drive axle have gone into the more-or-less standard truck equipment in 1959, with experimental work going to 600 hp for a single engine and greater horsepower going into multiple-engine units.

Along the conventional design, the year-end found trucks going into service with 600-hp engines and 90-ton capacity. An experimental unit designed to handle 120 to 150 tons of pay load is under construction. It will employ two 450-hp engines. Improved transmissions and axles are being used to take the high loads required by these large units, and to permit safe operation at economical speeds.

Interesting work is being done on the application of the "electric wheel" for truck use; that is, using an independent electric motor drive for each individual wheel unit. The electric power generator is a diesel-electric unit which is readily adapted to the high horsepower requirement. This design would seem to hold some possibility for the use of the turbine engine, with a horsepower capacity of 1200 and up being talked about for such an arrangement.

Tire cost on trucking often runs as high as 20 to 25 percent of the total operating cost, so this phase of large truck design continued to receive much attention. With the increase in truck size, there is a general step-up to tires of larger size. Steel cord casings of various designs are being tried out in an attempt to reduce tire weight and tire heat, and to improve casing life. Experimental designs with the steel cord bring the wall thickness of large tires down as low as ⅛ in.

The year saw much wider use of alloy steel in the large truck units, as well as some use of aluminum hopper body construction. Both show promise of improving the all important tare weight to pay load ratio.



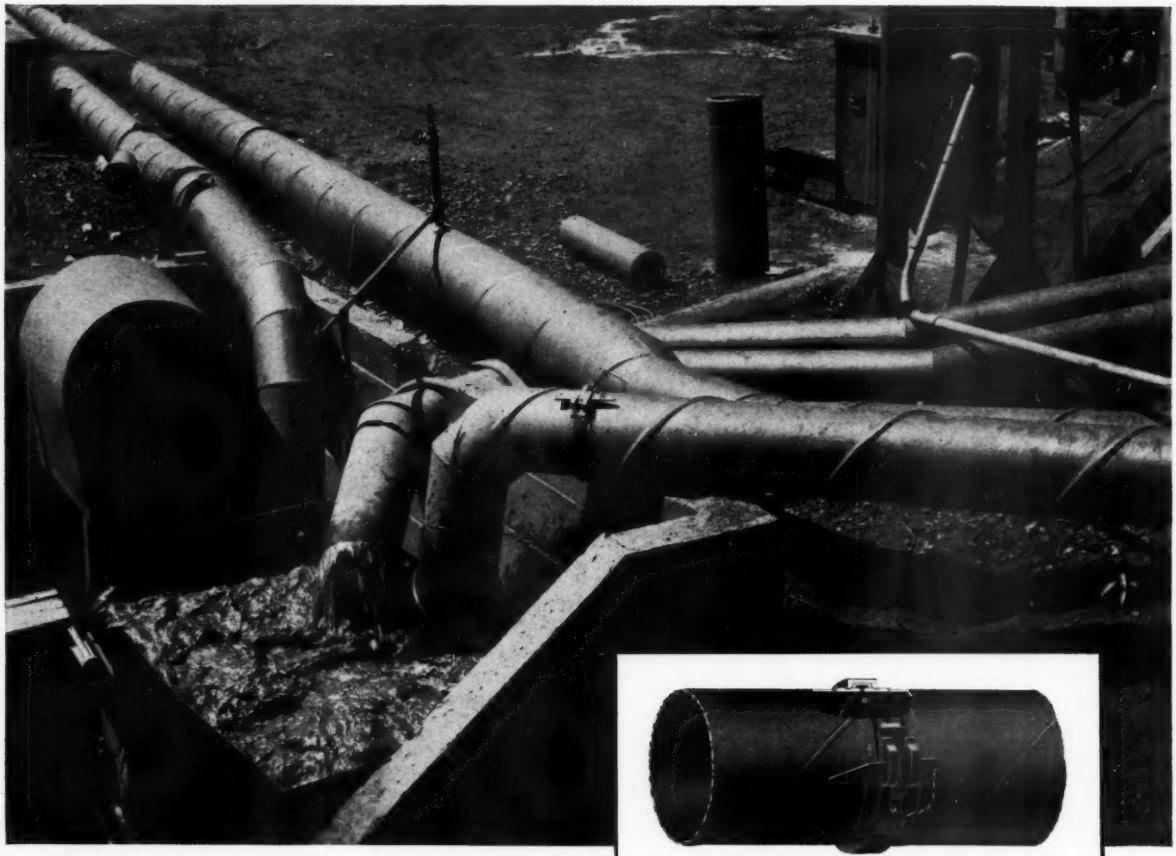
Will "electric wheel" trucks prove feasible in the mining industry?

Land Reclamation—Accent Is on Large Equipment

Progress continued on improved spoil bank reclamation. Here again the accent is on large equipment for leveling with the largest bulldozers

(*Continued on page 77*)

GET THE JOB DONE!



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IRON ORE

Increased mining activity in the U. S. for the first six months of 1959 was tied to a rebounding National economy and to expiration of steel industry labor contracts. With opening of the St. Lawrence Seaway early in 1959, foreign ores will be moving into the Great Lakes in ever increasing quantities. By 1965, imports of iron ore into the U. S. are expected to more than double the 1958 tonnage

By R. W. WHITNEY
Vice President-Operations
The Hanna Mining Co.

With nearly 40 years experience in iron mining, R. W. Whitney is eminently qualified to review the iron ore industry. He has had experience ranging from engineering through all phases of operations, to a series of managerial positions and has been a leader in advancing mining technology over the years. Well known on Minnesota's Mesabi Range as a "top operator" with M. A. Hanna Co. and Butler Brothers, Whitney became vice president-operations, The Hanna Mining Co., in 1957.

THE state of the iron ore mining industry today can be described very briefly. There is an ample supply of ore at the present time. We have more than enough under development for the immediate future. Over the longer term we're probably going to need a great deal of additional tonnage and will have to develop some entirely new deposits to provide raw materials for the iron and steel industry.

This article will review briefly our recent production figures, and will then discuss new developments in the two major trends that have completely transformed our industry in the past decade. These are: The mining of high grade ores in hitherto remote areas of the world, and the increasing use of high grade concentrates.

For the iron ore industry, 1958 was, at best, only an average year insofar as production is concerned. Total shipments of iron ore to U. S. consumers that year amounted to about 90 million gross tons, down over 30 percent from the 137 million gross tons shipped in 1957.

Ore Imports Increasing Sharply

In the year 1959, with the national economy on the rebound and with most steel industry labor contracts expiring at the end of June, demand for iron ore was at an extremely high level during the first six months. While more than welcome, this increase in mining activity does not have the long-term significance of a truly historical event that occurred this spring—the completion of the St. Lawrence Seaway—which has opened the Great Lakes to world shipping.

In the states that border the Great Lakes, we have most of this Nation's steelmaking capacity. For more than a hundred years these furnaces have been largely dependent on iron ore moved by boat down from the Lake Superior Region. Now we are seeing the beginning of substantial tonnages of iron ore moving into the lakes from outside the country.

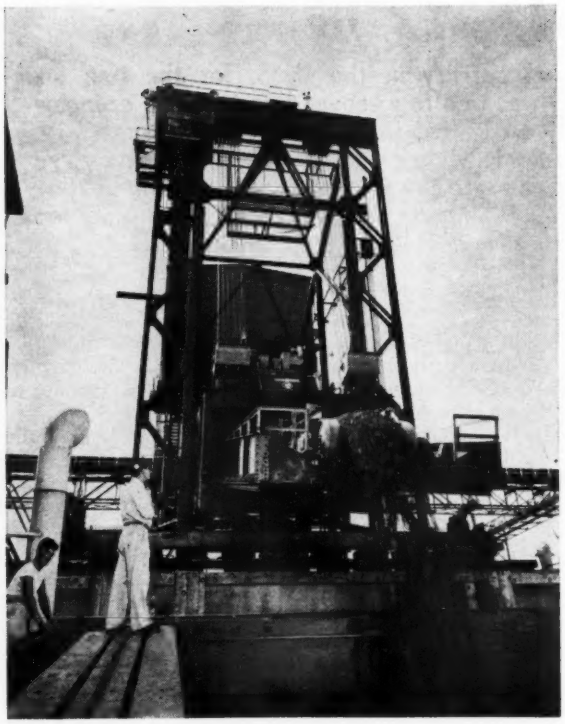
This past season, about five million tons of ore came into the Lakes through the Seaway, much of this from the Quebec-Labrador fields. However, there have also been regular shipments from Liberia and Chile, and the tonnages from those countries and elsewhere are certain to increase.

The Seaway is a key link in the chain of events that has enlarged our industry's horizons from a rather limited geographical area to world-wide scope in only a few years.

At the same time, technological improvements have made it feasible to concentrate lower grade ores into high grade concentrates, adding another dimension to our thinking.

Our customers, the iron and steel companies, for several years have been giving us some very simple, but urgent, instructions. They want increasing tonnages of higher quality blast furnace feed. The reason is obvious: The higher grade ore you charge into the top of a furnace, the more pig iron you get out the bottom. In this way, iron production is increased without the tremendous capi-

Trainload of iron ore enroute from Iron Ore Company of Canada's Labrador open pits to shiploading facilities at Sept-Iles, Que. Three big projects in the Quebec-Labrador region that are currently either under construction or in the advanced planning stage point up the fact that the iron ore industry has kept pace with an ever-growing demand—and will continue to do so in the future



This shiploader puts 6000 tph of iron ore into a ship destined for the United States at Puerto Ordaz, Venezuela. Whereas only four percent of the iron ore consumed in the U. S. in 1946 was imported, the figure increased to 27 percent in 1958

tal expenditures now required for blast furnaces, coke ovens and related facilities.

Let's look first at our sources of foreign ore and then review developments in the field of beneficiation. For the foreseeable future, this country's foreign iron ore interest will lie mainly in Canada, West Africa and South America.

Greater Iron Ore Supplies Needed

To illustrate the growth of iron ore imports, let's go back to 1946. That year about 2.8 million tons, or about four percent of the ore consumed in this country, was imported. In 1958 the amount of imported ore had increased to nearly 28 million tons and represented about 27 percent of the ore consumed in the United States.

Phenomenal as this increase may seem, some industry observers see our need for imported ore doubling by 1965. W. H. Johnstone, vice president of Bethlehem Steel, has predicted that the United States will need at least 60 million tons of imported ore annually by 1965 and the figure may well be closer to 65 million tons.

Where will this additional ore come from? With the target date only five years away, it's obvious that most of this increased tonnage must come from sources now being operated or at least under active development.

Canada's Iron Ore Industry Expanding Rapidly

For example, Canada—which currently can export 17 to 20 million tons of ore annually to the U. S. and Europe—should be capable of exporting 34 million tons a year by 1965. This would come from present operating facilities, some of which are being expanded, and from new developments already under way.

Right now, in the Quebec-Labrador Region there are three big projects either under construction or in the advanced planning stage. These could deliver up to 15 million tons of high grade concentrates by 1965. Iron Ore Company of Canada is working on a plant of six million ton annual capacity at Carol Lake, due for completion in 1962. Quebec-Cartier Mining Co. is building a similar plant at Lake Jeannine, with a goal of eight million tons of concentrating capacity by 1962. Wabush Iron Co. has tentative plans for a project of similar nature. Couple this with Iron Ore Company's production of direct shipping ore, which is in the 12 to 13 million ton range, and you have an extremely large potential tonnage of ore moving into the St. Lawrence River by 1965 from a region that had never shipped a pound of ore prior to 1954.

To the West, in Ontario, important growth in iron ore activity has taken place over the past 20 years. In fact, it was in 1939 in Ontario that Canadian iron ore production was resumed after a 15-year period of inactivity. By 1963, approximately ten million tons of direct shipping ore and concentrates should be coming out of the Lake Superior District of Ontario, much of it moving to its destination over traditional Great Lakes routes. This will come from such properties as Steep Rock Iron Mines, Bethlehem's Marmora operations, Inco's Sudbury plant and the Algoma ore properties plant in the Michipicoten district. In addition, a new taconite plant was placed in operation at Moose Mountain in 1959, Caland Ore Co. is due to start up an operation this year that will be able to produce three million tons annually by 1962. Anaconda Iron Ore has just revealed plans for a 100-tpd pilot plant on its property north of Nakina.

In Quebec, Hilton Mines' new mine and beneficiation plant were in operation for their first full year in 1958 and Jones & Laughlin has exercised an option to lease more than 5000 acres of iron ore property in the Kirkland Lake area.

New Developments in Latin America

In South America, all the known major deposits on both the East and West coasts are being carefully studied. Venezuela is an important source of high grade ore today, currently exporting about 15 million tons a year, and the potential is double or even triple that figure. Orinoco Mining Co. can produce 12 to 15 million tons and is considering expansion to 18 or 20 million tons. About 3½ million tons are coming from the El Pao deposit. Other properties are under active consideration for development.

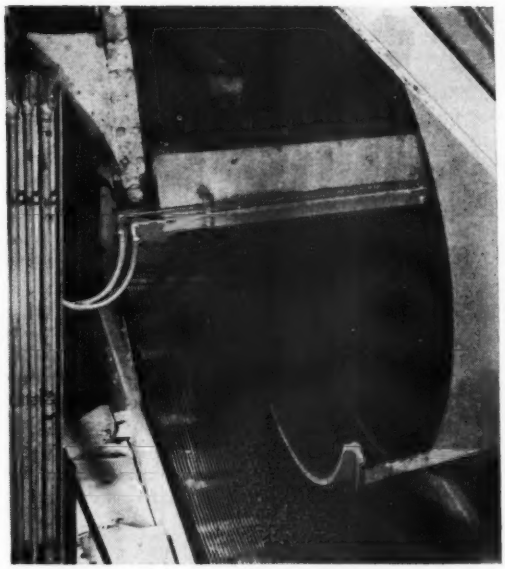
In Peru, The Marcona Mining Co. shipped 3½ million tons in 1957 and 2½ million tons in 1958, and is planning to expand its output to 5½ million tons within the next two or three years. Acari Iron Mines, with a rated capacity of about 1½ million tons annually, started production in 1959.

Chile has for many years exported ore to the United States. Bethlehem Steel's new Romeral Mine is exporting one to two million tons a year. Other smaller mines are producing a total of about 2½ million tons a year. Interestingly enough, a new deposit has been brought into production in Northern Chile and is due to ship up to one million tons a year to Japan. Initial survey work is under way at other deposits.

In Brazil, Hanna Mining is exploring and analyzing the large ore deposits on the St. John D'El Rey Mining Co. properties. Other groups are studying deposits in the same and different areas, and the present production represents three to four million tons per year.

Across the Atlantic, in West Africa, most current iron ore activity is centered in Liberia, where the Liberian Mining Co. has been exporting ore from Bomi Hill since 1951. This operation has recently been expanded to a rate of 2¾ to 3 million tons a year and there is some chance of enlarging concentrating facilities. Last summer it was announced that Bethlehem had joined with Swedish-American-Liberian interests to develop the Mount Nimba deposit. The contemplated capacity is about ten million tons a year for completion about 1962.

A study of the free world iron ore situation indicates that matters are reasonably well in hand for the immediate future. Over the longer range, however, a shortage of high grade foreign ore is definitely a prospect. Mr. Johnstone, in his report, declares that one or more substantial iron ore developments—in addition to the massive projects already under way—must be undertaken within the next five to ten years. Otherwise, the 1970's will see a world-wide iron ore shortage, with consequent rising prices on all ores, and other dislocations.



A balling drum discharges rolled concentrate balls onto a vibrating screen—part of the pelletizing process being used extensively in the Lake Superior district to meet an ever-increasing demand for high quality blast furnace feed

Improved Beneficiation Techniques

A fundamental aspect of any projection of this sort is, of course, the growth in tonnage of treated ores in this country. As we spend greater sums to develop high grade ores in out-of-the-way places, it also becomes feasible to spend more money for ore beneficiation facilities nearer home.

Certainly, *Mining Congress Journal* readers are familiar with the major developments in the field of low grade ore. Today, in the Lake Superior Region, we have eight plants capable of producing more than 15 million tons of high grade concentrates a year from taconite and jasper. These are new facilities. The oldest of these plants has been in volume production for only four years and the largest saw its first full year of production in 1958. Expansions are now being planned for at least three of these facilities, and some new ones are on the drawing board.

Prior to 1956, only negligible tonnages of these concentrates were produced. In 1958, the total approximated ten million tons; in 1960, production should total nearly 15 million tons. Over the years, these tonnages can be increased, other things being equal, for one of the important advantages of these ores is their vast reserve tonnage.

By no means have the changes in our industry been confined to importation of ores and concentrates. Our markets have become much larger and our transportation routes and materials handling methods have been changed and improved.

For example, iron ore being shipped out of South America, or West Africa, or the Gulf of St. Lawrence can just as readily be directed to the continent or to Great Britain as to the United States. Iron and steel producers in Europe have iron ore requirements similar to those of U. S. producers and they're turning to world markets to meet them. One important development occurred in this field during the winter of 1958–59 in Rotterdam with the opening of a large ore unloading and storage dock capable of handling the largest bulk carriers with the deepest drafts afloat.

I'd like to add here that when I say largest bulk carriers I'm talking about pretty big ships. On the Lakes, a boat with a capacity of 15,000 tons of ore is a good size vessel, and the largest can carry about 20,000 tons. Compare that tonnage with the cargo loaded into a bulk carrier at Seven Islands in the Gulf of St. Lawrence last year—53,600 tons. This is a world record for dry cargoes, but it is certain to be broken before long, for larger salt water ore carriers are being built every year. This is still another factor in our ability to mine ore greater distances from the consuming furnaces. The more ore we can load into one vessel, the farther we can transport it competitively.

Iron Ore Industry Will Keep in Pace

Underlying all the changes that are taking place in our business is the tremendous increase in consumption of steel throughout the free world. Unquestionably, the demand for steel will continue to rise with the population growth and with the increase in per capita consumption of steel. A recent paper prepared by the Secretariat of the Steel Committee of the Economic Commission for Europe indicates that Western Europe's steel consumption will nearly double in the next 15 years; from about 78 million tons annually in 1957 to about 152 million tons in 1975. During this same period North America's requirements are expected to increase by 50 percent, from about 100 million tons today to about 152 million tons a year in 1975. And in South America, the amount of steel required is expected to be nearly three times as great—22 million tons a year in 1975, as compared to about eight million tons today.

The evidence presented above indicates clearly that our ore supplies are more than ample for the immediate future. The long-term future is another matter; new sources of major magnitude will have to be developed. However, we know that there is plenty of good ore in the ground and I can say with complete assurance that the iron ore industry will provide the tonnage. At no time has the steel industry been hampered by a lack of ore. Sometimes it has been in somewhat short supply, but our industry has been able to deliver the ore in the past and it will continue to do so in the future.

INDUSTRIAL MINERALS

REFLECT BRISK ACTIVITY in the CONSTRUCTION INDUSTRY

As our nation grows, the business of industrial minerals—pushed by population increases and demands for higher standards of living—grows with it. Since World War II the dollar volume of industrial minerals produced in the United States has exceeded that of the metals. Only iron, uranium and copper are in the first division of dollar value with sand and gravel, cement, crushed stone, clays, fertilizer materials, and sulfur. A host of other industrial minerals have rapidly rising use and value curves.

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IN 1954, for instance, the total value of iron, copper, lead and zinc production in the United States was almost exactly $1.5 billion. The value of crushed stone and cement produced in the nation that year was nearly $1.4 billion—almost equalling the value of the four leading metals. If sand and gravel and clay were included, the total value of the four industrial mineral products would be almost $2 billion, or 25 percent more than the four metals.

Industrial Minerals Production Tied to Construction Activity

These figures have been cited to provide a factual background for understanding and appreciating the close relationship between industrial minerals and the vigorous population and industrial growth in our nation. This relationship is especially true for the large volume, low cost commodities such as the construction materials: sand and gravel, cement, crushed stone, clay for brick, pipe, and tile, gypsum, and materials for lightweight aggregates such as pumice, slag, cinders, and expanded shale. These materials are fundamental to growing communities and industrial centers—for buildings, roads, runways, dams, and harbors.

Not only is there large demand for construction materials but also for many other industrial minerals that would receive little attention were it not for rapidly growing population centers in which people's rising standard of living has created new and increased demands. For instance, the tremendous growth of the fertilizer industry has been in response to both the need for increased productivity from the land and the gradual metamorphism of farming into a major industry. The chemical industry probably provides the most spectacular examples of all. Since 1940 there has been greatly increased production of such raw materials as sulfur, fluorspar, salt, barites, titanium minerals, and borax to name a few, all of them in response to the large needs for inorganic chemicals. Not all of these "needs" are critical but all of them are real. Many of yesterday's luxuries are the so-called necessities of today and it is surprising what a significant effect the changing demands of the people can make upon the requirements for certain material resources.

These examples clearly indicate that the population growth and demands for higher standards of living are keys to expanding production and development of the industrial minerals. With this in mind, it is easy to understand that the future demand for industrial minerals of virtually every kind will certainly increase.

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Foose joined the Pennsylvania Geological Survey as an assistant geologist in 1939, becoming senior geologist in 1943. Three years later he organized the new Department of Geology at Franklin and Marshall College, of which he was professor and chairman until joining Stanford Research Institute in 1957.

Foose served as a geologist with the Pennsylvania Turnpike Commission during 1941 and 1942. He has been active as a consultant for the past 17 years, specializing in the fields of economic minerals, ground water, and engineering geology, and he has conducted geological investigations throughout the United States and Canada, Western Europe, North Africa, Mexico, Central America and Hawaii.

The close relationship of the fortunes of many industrial minerals to the fortunes of the construction industry was again evident in 1959. According to available statistics, total new construction put in place during the first nine months of 1959 as compared with the like period of 1958 was up 15 percent in dollar volume to a booming $40.995 billion. With major upward trends in military facilities, highways, new residential, commercial, and social and recreational buildings providing the greatest impetus, many industrial minerals enjoyed a good year. These include aggregates, asbestos, gypsum, clays, crushed stone, and others which contribute heavily to the construction industry. True, this picture does not include specific effects of the prolonged steel strike during the latter part of 1959 but, despite local strike influence, national indications point to a good year for these industrial minerals. As an outgrowth of this intense activity, there were many new mines and plants, many expansions, and further exploration efforts.

Two weak spots in industrial minerals were noted in the fluorspar and lithium industries which were adversely affected by the cessation of government purchases and forced to make significant cutbacks in production during the year.

The outlook for others such as feldspar, mica and talc which are more closely related to the general economic climate was one of near stability. Those which follow the fortunes of the oil industry, such as barite and bentonite, should have a year much like 1958 when a cutback in drilling resulted in a slight depression for these two commodities.

Gypsum ore is stored in giant domes at West Coast plants of Kaiser Gypsum Co. Gypsum's great virtues as a building material are that it is fireproof, easy to handle, structurally strong and attractive in finish

Aggregates

Aggregate production continued its role as a giant in the industrial minerals segment of the domestic economy, growing bigger as construction reached out for new records. During the first half of 1959, construction contracts set an all-time record for that period with large increases in residential and non-residential building categories offsetting declines in heavy engineering. Probably the most significant feature of the period was the strength showed by the private sector of the industry which climbed sharply despite a drop in government projects.

This healthy condition within the construction industry expressed itself in several ways in aggregate materials. First of all, exploration for aggregate materials was greatly accelerated. And second, new testing methods to determine the suitability of materials for aggregate were developed. As a result, many deposits formerly held in low repute and in some cases classified as waste, have been reevaluated and many now serve useful purposes. An excellent example of the rags to riches story in aggregate materials during the past several years is blast-furnace slag. Once thought of as a major nuisance by-product of steel, the slag market today is big business—and destined to grow bigger. The current annual production is in the neighborhood of 30 to 35 million tons with the bulk of slag sold finding uses in the construction market as aggregate for portland cement concrete, bituminous surface for nonskid highways, concrete masonry units, road fill, railroad ballast, and fibers for mineral wool.

Optimism appears to be the keyword for the future of lightweight aggregates. The consensus of opinion at the mid-year convention of the Expanded Clay and Shale Association in New York was that the market for lightweight aggregate will continue strong in the masonry unit field, while growing considerably in other areas such as structural precast and prestressed concrete. To help establish adequate supplies of lightweight aggregate, major research projects are now underway in a search for bloating clays and shales. It is anticipated that thermally expanded clay, shale and slate will play an important role in meeting the increasing demand.

Interest in other materials for use as lightweight aggregates continued. For example, a sudden increase in interest in volcanic tuffs in Oregon was reported. In West Virginia, a trend to greater utilization of the refuse from coal preparation plants for the manufacture of lightweight aggregates was noted.

Faith in the future of perlite was reflected in New Mexico where the Great Lakes Carbon Corp. and the United Perlite Corp. opened new deposits. In Nevada, the Combined Metals Corp. increased perlite production at its Pioche operations.

The problem of diminishing reserves of high-grade vermiculite is being countered by recent trends towards flotation treatment of lower-grade deposits.

Asbestos

The most striking development in the domestic asbestos industry during 1959 was the activity in California and Arizona, due primarily to the demand for asbestos in a variety of building products. California, second largest consumer of asbestos fiber in the nation, attracted the lion's share of interest. The Jefferson Lake Sulphur Co. recently optioned a 15,000,000-ton chrysotile asbestos deposit near Stockton, Calif., and formulated plans to install mining equipment and to erect a 2000-tpd mill. In November, it was reported that full production had been reached by the Clute Corp. asbestos mill near Napa, Calif. Union Carbide was actively exploring potentially important asbestos-bearing properties west of Coalinga, Calif. during 1959.

In Arizona, the Metate Asbestos Corp. opened its new asbestos processing plant in Globe and announced a production schedule for 30 tons of finished fiber a week. The Jaquays Mining Corp. was also operating in the Globe area, engaged in a development program on an asbestos property.

Barite

The domestic production of barite closely follows oil-well drilling activity. Statistics through the first 10 months of 1959 indicate that the footage drilled this year was only slightly greater than that during the same period last year when a cutback in drilling for oil had caused a slight recession. Thus 1959 will probably be a year of stability or slight improvement as compared to 1958. However, the oil industry looks forward to a gradual improvement in business throughout 1960; this should contribute to an upswing in the barite industry. A glance at the current economic climate for barite, however, does not allow one to grasp the "phenomenal growth" recorded since 1947. Sales by domestic producers have increased about 2½ times from the 1947–51 average of about 600,000 tons to sales of over 1.5 million tons in recent years.

A new barite mill in Dierko, Ark., is planned by the U. S. Glass and Chemical Co. Initial annual capacity will be 35,000 tons of barite. In Sweetwater, Tenn., the International Minerals Co. exercised options and purchased the Beverly Wood barite holdings during 1959.

Beryl

Beryl attracted attention during 1959 when Beryllium Resources, Inc. announced the purchase of the Mt. Wheeler mines in Ely, Nev. This large, lowgrade, disseminated beryllium deposit is estimated to contain over 100,000 tons of ore averaging 0.75 percent BeO. The mineral of importance is phenacite. In order to upgrade to a minimum of 10 to 11 percent BeO, a study of the application of a special reagent for flotation of the ore is underway.

A relatively new geophysical tool, the berylometer, was used to assist in evaluating the Mt. Wheeler deposit. This portable instrument is similar to a Geiger counter in that it gives readings in ore values—uses an isotope of antimony which emits gamma rays. The gamma rays excite the beryllium-bearing mineral or rock into the emission of neutrons. The rate of neutron emission is correlated to the ore grade. A description of this detector was published in the September-October, 1959, issue of *Economic Geology*.

Another new development, announced last May, was that the Wyman-Gordon Co. has designed a 50,000-ton pressure forging technique to produce large structural beryllium shapes. The finished products require a minimum of machining and are as ductile as strong aluminum alloys.

The Harding mine at Dixon, N. M., also attracted attention in 1959 when Texas interests announced studies were underway to design a mill to process the ore.

Boron

The exciting use of boron as one of the high energy fuels received a setback in August when government economy measures forced the cancellation of two big triethyl decarborane plants, one at Muskogee, Okla., and the other at Model City, N. Y.

The American Potash and Chemical Corp., as reported during May, is building the first large-scale commercial plant for the production of boric oxide at Trona, Calif. The oxide is to be used in high energy fuels as well as in various industrial applications.

Seven-ton bite of limestone is loaded in quarry truck by electric - powered shovel at Permanente Cement Company's plant near Lucerne Valley, Calif. The quarry annually will produce approximately 1,000,000 tons of limestone for cement manufacturing

A new, versatile fire-fighting tool is now available under the tradename of Firebrake, a United States Borax & Chemical Corp. product. This so-called borate bomb is used most effectively from aircraft, which dump a mixture of the chemical and water directly on or in front of the fire. To date, this chemical has been used to fight fires in forests, brushlands and rangelands from Alaska to Florida.

In Arizona, the Phelps Dodge Corp. was exploring for borax near Kingman, and in California, at least four major companies have conducted exploration for boron in Kern and San Bernadino counties. The Kern County Land Co. announced the discovery of a 40,000,000-ton deposit of colemanite on a holding east of Boron.

Ceramics

The tempo of business in the ceramic industry is lively with most divisions within the industry enjoying a high level of activity. Floor and wall tile, sanitary ware, architectural products and others which contribute to a large extent to the construction world continued at brisk levels of production. In the electronic ceramic field, the economic picture was mixed. Producers of high alumina products were enthusiastic in their reports of increased business encountered during 1959 and a number of plant and product line expansions were reported. Other segments of the electronic ceramic industry were not quite as enthusiastic with some fairly strong competitive situations developing in products such as steatite and ceramic compactors. There was also a high level of business for hotel china even though plastics and imports created minor trouble. All in all, 1959 was a good year for ceramics and prospects for a better 1960 appear favorable.

Some of the new developments in ceramics during the year reflect the increasing interest in the space age. Ceramic coatings for space vehicles are being evaluated and reportedly show promise because of their stability to ionizing radiation and volatilizing effect of high vacuum, and also resistance to micrometeorite damage. And being evaluated for use on a flush-mounted missile, radome is a new fused silica by Corning Glass which can be produced in sizes and shapes never before possible by conventional ceramic forming.

A challenge to high temperature metals by the nonmetallics was also evident. Britain's Admiralty Materials Laboratory developed a new material which is fundamentally a silicon nitride stiffened by a five percent dispersion of silicon carbide to improve creep strength. This ceramic is being considered for a wide variety of applications in temperature environments up to 1200°F.

Although still in an experimental stage, Horizons, Inc. announced the development of a method to form ceramic fibers of high bulk density which maintain their shape at high temperatures, reportedly up to 4500 F.

Armour Research Institute has developed a porcelain-like rare earth oxide and alumina, zirconia, titania mullite, and iron-titanium oxide lining which is sprayed on engine parts. This treatment holds promise of improving combustion by containing heat within the cylinder and speeding the oxidation reaction of hydrocarbons.

Another possible product for the automobile industry is the system for ceramic-coating mufflers which will

protect them from corrosion and burning and thereby double their expected life.

The General Electric Research Laboratory developed a new polycrystalline ceramic which transmits at least 90 percent of light. Possible applications for it are in extending service of high temperature lamps, in infrared lamps, missile nose cones, and a wide range of scientific, military and industrial uses.

Clay

Domestic clay production, according to recent figures published by the U. S. Bureau of Mines, decreased four percent in 1958 as compared with 1957. Although the figures for 1959 are not immediately available, all indications point to a production total similar to or slightly better than that registered in the preceding year.

J. R. Simplot Co. began constructing a clay-beneficiation plant near Bovill, Idaho. The facility, which is scheduled for completion in early 1960, will beneficiate local clay to a product suitable for paper and ceramic uses. Silica sand will be produced as a co-product at the plant.

In Alabama, a program of sampling widespread occurrences of clay and shale deposits over the entire state is being continued. The Ceramics Station of the U. S. Bureau of Mines is testing these samples to determine whether they are suitable for brick and tile, lightweight aggregate or other possible uses.

Crushed and Broken Stone

Recently published Bureau of Mines figures show that production of crushed and broken stone reached a record high of 533 million short tons valued at $746 million for 1958. Limestone and dolomite, quarried in 46 states, accounted for 73 percent of the total crushed stone in 1958. Furnace flux amounted to seven percent of the total limestone produced.

The continued high level of construction and steel activity prior to the steel strike pointed to the possibility of another record-shattering year during 1959 for the crushed stone industry. The steel strike, however, resulted in declines in the consumption of limestone for flux and in many segments of the construction industry where steel products are essential. Notwithstanding these difficulties, the picture for the crushed stone industry for 1959 was bright.

The tremendous volume of material contributed by the crushed stone industry to satisfy present-day demands for even one project was forcefully brought home when it was reported that the Chantilly Crushed Stone Co. of Chantilly, Va. will have supplied about 1,300,000 tons of crushed stone for the construction of Washington's new $75,000,000 Dulles International Airport during 1959. This tonnage includes material for the sub-base and concrete and bituminous concrete aggregate.

Diamonds

General Electric Co. must face the possibility of a new rival in the manufacture of synthetic diamonds. The competitor is the DeBeers diamond trust which controls nearly all the natural diamond sales in the world outside Russia. Although DeBeers has discovered a process for making synthetic industrial diamonds, its management has not yet decided whether to market these for commercial use. If DeBeers decides to market synthetic diamonds, it could intensify competition in the industrial diamond field.

In Johannesburg, the Diamond Research Laboratory recently started a program of detailed analyses of Kimberlite from numerous localities. The purpose of this work is to find out whether there is a correlation between any minor element content and the presence or absence of diamonds. If any connection can be established, it should aid in the search for new diamonds.

Fluorspar

A bleak outlook confronts the domestic fluorspar industry. Ever since the government purchases of fluorspar for stock piling ended on December 31, 1958, declines in consumption have been noted. As government purchases had been the outlet for a large share of the non-captive production in Illinois and Kentucky, the cessation of stockpiling brought about major curtailments in operations and drastic reductions in working forces. The industry's main hope for improvement lies in legislative relief from large foreign imports.

An interesting new use for Illinois fluorspar was demonstrated recently in the public water plant at Rosiclare, Ill., after the installation of a fluoridating device allowed the substitution of Illinois fluorspar for manufactured fluorides and resulted in a reduction of raw materials costs.

In Europe, the treatment of concrete products with silicon tetrafluoride vapor is being increasingly used to improve chemical and wear resistance, compressive strength and impermeability.

Glass

A glimpse into the crystal ball and the picture of the glass industry is clear. Another stride forward during 1959 and a bright outlook for 1960. In flat glass, the expected increase in 1959 sales over 1958 is ten percent which should make it the third highest peak in this segment of the industry. The outlook for 1960 is one of the optimism based on the growing population and the well-established trend toward the use of larger areas of glass in automobiles and in all types of buildings. In line with this trend, the Ford glass plant at Nashville, Tenn., is doubling production of automobile glass.

The glass container industry is not ready to take a back seat either. On June 8, 1959, the Business and Defense Services Administration, U. S. Department of Commerce, reported that glass container shipments in 1958 amounted to 142.7 million gross, substantially the same as the all-time record established in 1957. The 1959 shipments of glass containers is expected to exceed the 1958 shipments and dollar volume by about six percent based on long-term trends. This outlook is further supported by the general stability of the glass container market and the anticipated upward trends in population and consumer purchasing power.

Graphite

A revolutionary development in the domestic graphite industry was also reported during 1959. The National Carbon Co. announced the development of a process that converts organic textiles directly into a high purity graphite. For example, when rayon is heated electrically to 5400° F, a thermochemical conversion changes the crystalline structure of the rayon to graphite. The potential outlets for the synthetic graphite include refractories, electrical conductors, filter bags for hot dust collectors up to about 750° F, electrostatic precipitators, flame arrestors, curtain walls, the handling of corrosive fluids on a filter, self-lubricating bearings, conveyor belting and electron wiring.

Gypsum

The rapidly increasing demand for gypsum was reflected in the record sales and earnings which were reported in this industry during the first half of 1959. National Gypsum Co. sales and earnings for the first half of 1959 jumped 44 percent and a tremendous 104 percent respectively over 1958 first-half figures. U. S.

Gypsum also set new records in sales and earnings during this six-month period with a 19 percent increase in sales and a 32 percent increase in profits over a like period in 1958.

During 1959, U. S. Gypsum opened a new mine at Sperry, Iowa, and enlarged their existing gypsum board plant at Jacksonville, Fla. National Gypsum's major expansion program at its Savannah, Ga., plant makes it "the largest gypsum plant in the world." Total output will now be sufficient to produce enough gypsum wallboard, lath, plaster and other products for approximately 100,000 homes a year.

Kaiser Gypsum Co., Inc., announced plans to build a multimillion dollar gypsum products plant at Rosario near Albuquerque, N. M. In Edgewater, N. J., during March, Allied Chemical's Barrett division started construction of a new calcining plant which will handle up to 20,000 tons of gypsum ore in one load. The plant will process Nova Scotia ore and pass it on to an adjacent gypsum plant that can turn out 800,000 sq ft of gypsum board a day. American Gypsum Co. also plans to build a $3,000,000 plant near Albuquerque. In Wyoming, Fremont Mining and Manufacturing Corp. reported a 70,000,000-ton gypsum deposit near Lander and set up plans to build a mill and blend the gypsum with raw phosphate, sulphur and trace minerals to make soil conditioners. Vipont Mining Co. was also interested in starting a mine and mill near Lander, Wyo., with the discovery of a 100,000,000-ton gypsum deposit in the Wind River formation. The Fibreboard Paper Products Corp. planned a 60-percent increase in gypsum board capacity at its South Gate, Calif., plant following the discovery of a 750 million ton high-grade gypsum deposit located near Apex, Nev.

Lithium

The halt in government purchases of lithium which had been going to the Atomic Energy Commission caused significant production cutbacks in this industry during 1959. The Foote Mineral Co. and the Lithium Corp. of America, both controlling considerable spodumene reserves in the Kings Mountain district, N. C., announced reduced rates of operation about mid-year. However serious this development may be, some members within the lithium industry consider this setback as temporary, and believe that one factor which will relieve the situation will be a substantial growth in civilian uses. The door to a potentially large-scale use for lithium was recently opened by a new lithium purification technique. This technique removes corrosive-causing nitride and oxide impurities which could result in the low-melting alkali metal being used as a coolant for nuclear reactors and in other types of heat transfer systems.

Pumice quarry at the foot of Glass Mountain, Calif. Pumice from this 60-ft deep mantle-like deposit is used as aggregate in lightweight concrete

In August, Lithium Corp. of America announced it will move its entire laboratory and manufacturing operation to Bessemer City, N. C., from Minnesota. With this consolidation, the Bessemer City plant will be the only one in the United States processing lithium from ore to finished product.

At Columbus, Ohio, an ammonium and lithium perchlorate plant, jointly owned by Hooker Chemical and Foote Mineral, was completed during February.

The Texas Gulf Sulphur Co. is currently evaluating the possibilities of locating a lithium plant in the Lincolnton, N. C., area near the site of a potential spodumene deposit.

Mica

As in the past, the United States continued to be a major producer of scrap mica but produced very little sheet mica during 1959. Reports from important mica-producing sections of the nation indicate the mica industry will do slightly better in 1959 than in 1958, a year which showed a decline in values of both commodities.

The reported developments during 1959 included the successful exploration project for strategic mica conducted under the DMEA at the R. B. Phillips mine in the Spruce Pine district of North Carolina. Mining subsequent to the discovery has yielded the largest production of strategic sheet mica from any single mine in the United States in recent years.

In Colorado, the Mount Olympus Mining Corp. increased production at the Poudre Canyon mica processing plant. And north of Santa Fe, N. M., the operation of a new mica mine and mill was started by a group which included the Clute Corp.

A note of interest concerning foreign mica—the United States has announced its intentions to terminate all stockpile purchases of foreign mica by June 30, 1960.

Refractories

Several new developments took place in the refractory business during 1959. As a result of long research, General Refractories and Harbison-Walker have introduced a new basic brick for the roof of the open-hearth steel furnace. This brick allows furnace operating temperatures to be boosted from 3000 F, the limit for silica brick, to 3200 F. The aim of the new basic brick is to increase steel output. By forcing oxygen through a lance into the furnace, steelmakers are doubling the previous steelmaking rate at 20 to 30 tph.

Another development—a new vitreous, high-purity magnesium oxide ceramic—was announced by the Refractories Division of the Carborundum Co. This product combines the high purity of the somewhat porous MgO crucibles with doubled strength and greater resistance to molten metal attack.

The H. K. Porter Co. developed a new 80 percent alumina plastic refractory which is recommended to balance refractory linings in high temperature installations and for linings where iron oxides and molten aluminum are prime causes of failures.

In Niagara Falls, N. Y., the Carborundum Co. is working on the development of boron nitride at a semi-commercial scale. The process adds alkaline earth compounds to impart a "superior resistance to attack by water and alcohol."

H. K. Porter Company's multimillion-dollar plant for the production of magnesia from sea water and the manufacture of refractory brick was completed at Pascagoula, Miss., in August.

Kaiser Chemicals announced plans for a new plant to produce refractory magnesia to be built at Midland, Mich. The Mexico Refractories Co. will build a refractory plant near Herald, Calif., and will presumably use the Ione formation of Eocene age as a raw material source.

A new research center—the Garber Research Center—was opened in Pittsburgh by Harbison-Walker Refractories Co.

And the formation of the Harbison-Carborundum Corp. for the engineering, manufacture and sale of fused refractories was announced by Harbison-Walker Refractories Co. and the Carborundum Co. The new firm's products include alumina, chromite and zirconia base refractories for the glass industry, chromite and magnesia base refractories for the steel industry and other auxiliary items for fused refractory applications.

Of interest as an indication of potential future developments is the considerable increase in production of crushed olivine from the Twin Sisters quarry by the Northwest Olivine Co. of Seattle, Wash. This material makes superior molding sand, it is excellent for refractory use, and it is also a potential ore of magnesium.

Salt

The United States stands well above any other nation as a producer and user of salt, and this fact demonstrates the nation's industrial dependence on salt. The basic nature of salt for foods and as an industrial raw material, together with this nation's immense reserves, gives the domestic salt industry a high degree of economic security. True, there are periods of slight recessions. During 1958 the production of salt in the United States dropped 14 percent from the 1957 figure but still remained at an impressive 20.6 million tons. This decline, the first major interruption in salt's steady growth, caused little concern among producers. An example of the conviction of a resurging demand—Morton Salt opened the first new U. S. mine in 25 years during 1959. This mine, the Fairport Mine, near Painesville, Ohio, is the deepest salt mine in the United States. It taps a vast bed of rock salt, 2000 ft below the surface, that extends from far under Lake Erie southward to West Virginia. Reserve estimates exceed 200 million tons.

International Salt has developed a process for separating salt from impurities by selectively heating the impure materials with a battery of infrared heat waves. The separation is possible because the sodium chloride crystals are transparent to the heat waves whereas the impurities are not. After heating the actual separation takes place by the use of a heat sensitive adhesive which is used on a high speed conveyor belt. Rock salt, which will not adhere to the resin, drops off the conveyor into a catch bin.

Soda Ash

Green River, Wyo., was the scene of soda ash interest during 1959 as at least four companies—Stauffer Chemical, Diamond Alkali, Ruby Mining and Chemical Division (J. R. Simplot), and a group of Texas interests—engaged in exploration activities.

A process designed to recover soda ash from spent sulfite liquor was put in commercial operation at Consolidated Water Power & Paper Company's Wisconsin Rapids, Wisc., plant during 1959. Developed by Western Precipitation, the recovery system makes sodium-base sulfite pulping competitive with the traditional calcium-base route and gives bonuses of high pressure steam and pollution control.

Talc, Soapstone and Pyrophyllite

Domestic mine production of talc, soapstone and pyrophyllite increased eight percent in 1958 over 1957 and approached the record high of 1956 according to a recent report by the U. S. Bureau of Mines. New York, California and North Carolina continued to rank as the first three in the quantity of talc, soapstone and pyrophyllite produced. Although final statistics are not available for 1959, the indications point to a year of stability or slight increase over last year's total production.

Pyrophyllite concentrates of the proper quality are becoming of increasing importance in the manufacture of high-grade ceramic wall tile and considerable research is being carried out to meet this requirement. From North Carolina, the major pyrophyllite-producing state, came word that there is an increasing amount of production of pyrophyllite refractories in that state.

The Pioneer Talc Co. of Chatsworth, Ga., started the erection of a new talc mill in the Hudspeth County talc district of Texas during September.

Other Minerals

Recent statistics showed that the production of bentonite dropped 11 percent in 1958 from 1957. Indications during 1959 point to a slight improvement.

In Nevada, the Eagle-Picher Co. continued to expand operations at its Colado diatomite plant which was completed late in 1958.

Magnesium made news in Selma, Ala., where a plant was erected to treat Alabama dolomite to make magnesium metal. This is the first time magnesium metal has been made in Alabama.

The feldspar industry in North Carolina, a leading state producer, has undergone important changes in recent years. Formerly, large pegmatites were the raw material source but with the exhaustion of these deposits, the industry shifted to fine-grained pegmatite (alaskite), and flotation took the place of cobbing. The result—four flotation plants operated by three companies are active in the Spruce Pine district which is underlaid by approximately 250 square miles of alaskite. With continued investigations and research underway to improve the quality of the feldspar and by-product mica and quartz sand, the future of this district appears to be strengthened.

At Johnson City, Tenn., Dupont opened a new titanium dioxide plant which will produce about 12.5 tons of titanium dioxide a day and will employ more than 400 people with an annual payroll of $2,500,000.

ANTHRACITE

Production off about eight percent, but industry sees rays of hope on the horizon

By H. W. BRADBURY
President
Glen Alden Coal Co.

DURING 1959 considerable progress was made in reducing the unit cost and improving the quality of anthracite.

Before commenting about the future, some economic factors which seriously affect many anthracite producers should be outlined. While there has been some relief through a reduction of property taxes levied by various municipalities, there must be a more realistic look at the whole picture by the taxing authorities. Certainly coal companies should not be expected to pay taxes based on approximately the same assessment that existed years ago when the industry was selling three times its present tonnage.

The Federal Government and the Commonwealth of Pennsylvania have extended excellent cooperation under the Joint $17,000,000 Mine Drainage Program. This program has furnished and installed deep-well pumps, and built ditches and flumes to divert water from the mines. However, it is Glen Alden's position, shared by other Northern Field operators, that there must be further assistance from the government in paying for the actual pumping charges in abandoned mines. As an example, Glen Alden is now saddled with a higher pumping cost because of the Knox mine disaster on January 22, 1959, and the resultant drowning out of practically all of the Pennsylvania Coal Co. and Lehigh Valley Coal Co. mines. New pumping stations are now being erected on Hudson property to pump water not from Glen Alden and Hudson Coal Co. mines but to stop the flow of water from these abandoned mines entering Glen Alden and Hudson properties.

H. W. Bradbury was a soft coal miner from his early youth until 1954. His first experience with anthracite came in 1953 and in 1954 he was named president of Lehigh Valley Coal Co. and Lehigh Coal Sales. In April 1958, he was made executive officer of Glen Alden Corp. and in mid-1958 became president. When Glen Alden and List Industries Corp. merged in April 1959, he was made vice president of the parent company, president of the Coal Division, and president of Blue Coal Corp., the sales subsidiary of Glen Alden.

Anthracite producers, in cooperation with the Federal Government, did considerable work during 1959 on improved mining techniques. One new development offering considerable hope is being conducted in a mine in the Southern Field using a Goodman boring type continuous mining machine. Results to date indicate greatly accelerated rates of production as compared with hand mining. Certainly, looking to the future, strip mining areas will gradually be depleted and stripping operations which remain are becoming more costly because of the great depth and costly job of moving overburden. The anthracite industry through mechanization must improve its cost factor in deep mining.

Utilization Research Holds Key to Future

The Federal Anthracite Research Laboratory at Schuylkill Haven, Pa., is spending over $600,000 annually on anthracite utilization research and improved mining methods. In the utilization field, all efforts are pointed at the finding of new uses in the metallurgical and gasification fields. While no tangible results have been announced to date, definite progress is being made and there is a basis for optimism about the future.

The metallurgical field holds promise of offering a new market for anthracite. Large amounts of anthracite are already being used for sintering, for taconite pelletization and as an admixture with bituminous coal in the manufacture of metallurgical coke.

The possible use of anthracite, either in its basic form or in a calcined form, for use in blast furnaces and foundry cupolas is being thoroughly investigated. The quality, availability and cost of metallurgical coke are imponderables that have a great bearing upon the acceptance of anthracite in the blast furnace and foundry cupola markets. Any unfavorable situation with regard to metallurgical coke would greatly expedite the expanded metallurgical uses of anthracite.

Another situation being watched closely by the anthracite industry is the possible use by the steel industry of one or more of the various processes being offered for the direct reduction of iron ore. Anthracite would be a preferred fuel for such an operation and the general adoption of the steel industry of the direct reduction process should create a sizeable market for anthracite.

One anthracite company, in cooperation with a large chemical company, has announced plans to establish a company to produce chemical and other industrial gases from anthracite silt and culm banks.

The Commonwealth of Pennsylvania has appropriated $250,000 during the past biennium for anthracite research. The major part of this program is being conducted at the College of Mineral Industries, The Pennsylvania State University, on basic anthracite research.

A comparison of the anthracite heating equipiment that was available at the end of World War II with equipment on the market today, convincingly demonstrates that great progress has been made in the improvement of anthracite domestic and commercial heating equipment.

Representatives of bituminous coal and anthracite are appearing before Congressional committees in the interest of establishing a national fuels policy. Coal is urging that a national fuels policy be established to assure

the availability of fuels adequate for an expanding economy and for the security of the United States. Certainly the unrestricted importation of foreign oil and the recent Federal Power Commission approval of the importation of natural gas from the Alberta fields are important subjects which should be discussed in any consideration of a national fuels policy.

The cordial and cooperative spirit that characterizes the relations of anthracite operators and the United Mine Workers of America was again evident in the formulation of a new wage agreement, effective February 1, 1959, with no inconvenience to the consuming public.

Home Heating Promotion Pays Off

While the tonnage of the larger domestic sizes of anthracite has continued to decline due to competition of oil and gas, considerable progress is being made in the sale of modern automatic anthracite units. Every effort is being made to urge retail fuel dealers to promote this modern equipment. It is apparent that retail fuel dealers in our primary market can no longer expect an automatic increase in their fuel oil business because of the natural gas competition. Anthracite equipment is their best sales weapon in combating natural gas because of the savings in operating costs plus the greatly improved convenience of modern automatic anthracite units.

Anthracite producers in the Wilkes-Barre-Scranton-Hazleton areas are now sponsoring a 15-minute television news program on WNEP-TV, Channel 16. This program will feature the outstanding advantages of heating with modern anthracite equipment.

More and more the industry is finding greater interest on the part of builders in modern anthracite equipment. One hundred new homes were recently built in Berwick, Pa., and equipped with automatic anthracite units. An on-the-spot canvass of 12 owners of the new anthracite-heated homes disclosed that all the owners, without exception, were enthusiastic about their heating systems and spoke in glowing terms of the comfort, convenience, cleanliness and economy they received.

While it is predicted that the anthracite over-all production will show a decline of approximately eight percent from that in 1958, I believe that the downward sales curve is leveling off and there are indications that anthracite will make advances in the future. And so we at Glen Alden, appreciating the existence of many and various problems, look hopefully to the future.

STRIP MINING OF COAL

(*Continued from page 65*)

built taking over the job of smoothing out the spoil piles at the lowest possible cost. Much experimental work is being done with various cover crops for the most rapid recovery of the land. In some soils the use of a legume such as Crown Vetch, with its ability to protect the soil moisture and its aggressive creeping characteristic, has made possible remarkable recovery of the fertility of spoil areas. Considerable use was made of seeding by airplane which gives good results at low cost. Work also continued on determining the suitability of tree species for the various areas. Pulpwood crops are being given consideration for some areas where a market possibility for these trees seems to be feasible.

Remotely Controlled Machine Being Developed for Highwall Mining

Depletion of strip reserves gave further impetus to work on methods of recovering coal just beyond the stripping depth. Multiple auger-type machines are being tried, as well as various modified types of underground mining. Perhaps of greatest interest was the announcement made during the year that Joy Manufacturing Co. had acquired the extensive work done by Union Carbide Co. on a highwall mining machine, and had teamed up with a large operating company, Peabody Coal Co., to further develop this machine. The unit is proposed for depths of 1000 ft and includes elaborate automation of the mining machine for remote control. A unique helical storage arrangement is used for its long extensible conveyor.

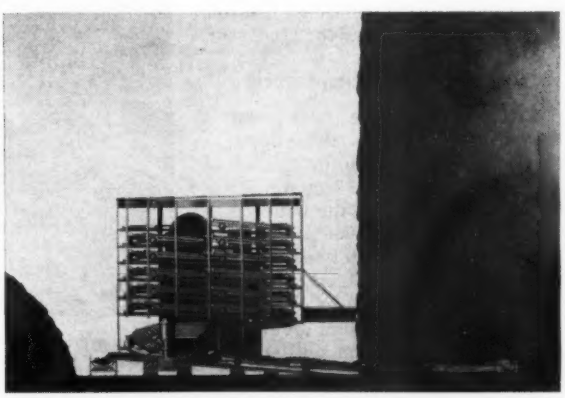
This phase of strip mining, which represents the crossover from strip mining to underground mining, is bound to receive an increasing amount of attention. However, one problem is to establish the point at which strip mining stops and highwall mining begins, as the development of larger stripping machines keeps pushing this point to greater bank height.

Improvements on Small Equipment Emphasize Efficiency

The large part of strip coal tonnage still comes from more easily mined areas where relatively small equipment can be used. Here the accent, during the year, was on improved efficiency of equipment and reduced maintenance.

Weight-strength ratio is the all important factor in excavation and transportation design, and 1959 saw increased application of higher strength steels, along with improved welding and fabrication procedures, to strip mining machinery. This trend is common ground for the large and small excavation equipment, and is all important to reducing strip mine cost.

The strip mining industry is essentially an earth moving business and, due to the rapid depletion of low-cover reserves, the ratio of overburden to coal must constantly increase if strip mining is to maintain its proportion of the coal market. The industy's answer to this problem in 1959 was largely in the engineering of larger equipment with ever increasing horsepower controlled per worker. We are awed by the present size of much of the equipment, but the future will apparently continue this trend with no limit in sight.



A remotely controlled machine for highwall mining is being developed for Peabody Coal Co. Note the unique helical storage arrangement for the extensible conveyor

As head of one of the Nation's major aluminum producers, D. A. Rhoades' remarks on the light metals are particularly pertinent. His varied career with Kaiser began in 1927 as a gravel inspector following graduation from the University of California. He later was operations manager for both Permanente Cement Co. and Permanente Metals Corp., the latter of which was the predecessor of Kaiser Aluminum. Until his elevation to the presidency in 1959, he had been vice president and general manager for 13 years.

State of the Light Metals

Because of constantly rising standards of living and the rapid growth in population, among other things, the world's extractive, fabricating and distributive industries are going to be pressed to the extreme to meet requirements

By D. A. RHOADES
President
Kaiser Aluminum & Chemical Corp.

IT is somewhat difficult to discuss the light metals, or any metals for that matter, at a time when the nation's metal operations have been so gravely disturbed. Many organizations are facing difficult situations in labor relations, operating schedules and dwindling inventories. Many fabricators desperately need metal.

One can only say, "When is the metals business ever normal?" If all of us decided to wait until everything settled down for a few years and we knew exactly what the score was, we would begin to suspect that we were in a rut. Then we would be unhappy, too.

And of course, we *would* be in a rut! Change and crisis are but parts of the larger and constructive picture in American metals. Regardless of the day-to-day problems, the overall programs of our various metal industries have demonstrated that they all add up over the years to increased capacity, greater range and quality of products, and improved capability to service and support the nation's ever expanding metal-working economy.

Let us look at the statistics of the two principal light metals, magnesium and aluminum, during the past year.

Magnesium Consumption Up

In magnesium we have seen a steady recovery from the effects of the recent recession. In the opinion of A. W. Winston, Sr., of Dow Chemical Co. who has provided the writer with information on magnesium, consumption of this light metal in 1959 approached 45,000 tons as compared to 35,000 tons in 1958.

The uses of magnesium are divided almost equally between military and commercial. On the military side, magnesium has established itself as a missile metal and is now being used in about 20 different missiles, including the Titan, Bomarc, Nike Hercules, Snark, Mace, Matador, Falcon and Talos. The Discoverer satellite's skin and fairings are fabricated entirely from magnesium and the skin of the Vanguard satellite likewise is magnesium sheet. An interesting aspect of magnesium missile development is the increasing use of magnesium-thorium alloys, which retain good mechanical properties at elevated temperature.

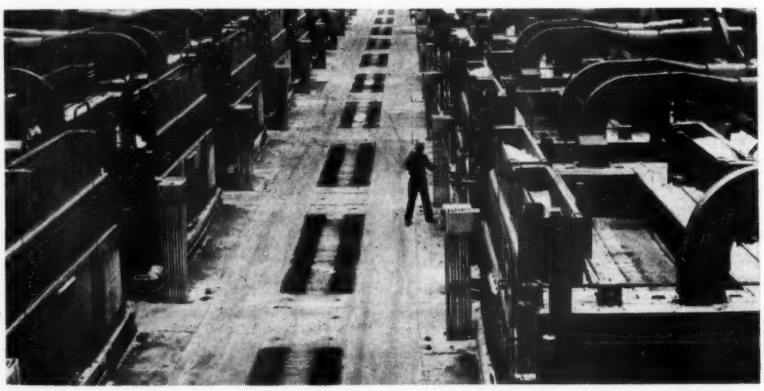
The decline in aircraft production has had a marked effect on magnesium consumption. The loss of consumption in aircraft has been only partially replaced by missile production.

Electronic equipment, ground support equipment and ground vehicles are other outstanding military applications of magnesium.

In the commercial area, the chief uses of magnesium are in luggage, tooling jigs and fixtures, materials handling equipment, portable tools, office machines, ladders and cameras. Development of an improved automatic metering die-casting process for magnesium has put this metal in a good position to compete in the automotive market. Magnesium has long since proved its structural adequacy in automotive applications, but volume use has been held up pending more favorable economics.

Magnesium also has many chemical and metallurgical uses, the most prominent of which is alloying with aluminum.

A major development in the magnesium industry since World War II has been the invention of new alloys. Magnesium alloys utilizing aluminum and zinc were widely used during the war and are still the backbone of the industry, but new compositions containing rare-earth metals, thorium, zirconium and even silver have been developed both in this country and in Britain. More than 30 basic magnesium alloys are now available in the United States, and many are available in more than one form or more than one temper.



Interior view of one of 18 huge pot-room structures which house the nine reduction lines at the Kaiser Aluminum & Chemical Corporation's Chalmette plant, near New Orleans, La. Chalmette is the nation's largest aluminum reduction plant

A new primary magnesium producer, the Alabama Metallurgical Corp. started commercial production late last year at Selma, Ala. The new producer uses the ferrosilicon process and dolomite ore, as does the New England Lime Co. in its plant at Canaan, Conn. Dow produces magnesium by electrolyzing magnesium-chloride cell feed, for which sea water is the raw material, at Freeport, Tex.

Now to move to the aluminum industry:

Primary Aluminum Capacity Increased 200 Percent

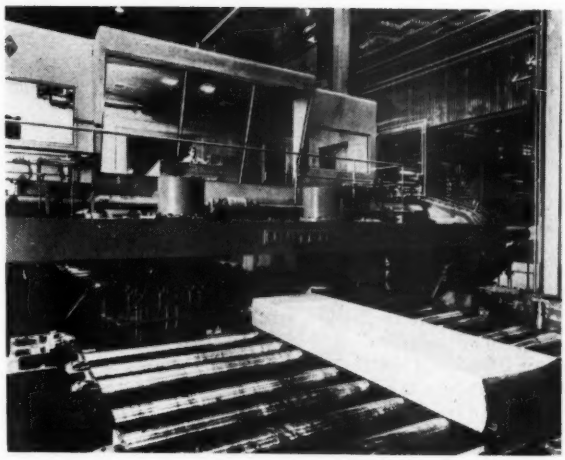
As a help in gauging the recent rapid development of the aluminum industry in the United States, we may note that just ten years ago the reduction capacity of the three primary producers was 1.5 billion lb. As of June, 1959, primary reduction capacity in the United States was nearly 4.7 billion lb representing over a 200 percent increase since 1950. In addition, another 0.5 billion lb of new capacity is currently under construction, which will give the industry a total of 5.2 billion pounds of primary capacity to meet the needs of the existing market. Not only has capacity increased, but also the number of primary producers has doubled since 1950, from three to six.

Industry Operated at About 83 Percent of Installed Capacity

Reflecting these expanded facilities, the U. S. aluminum supply picture has changed drastically over this period of time.

There are two sources of aluminum supply—primary, or virgin aluminum, produced from bauxite; and secondary aluminum, representing a recycling of scrap metal.

The supply of primary aluminum includes new metal produced domestically, as well as primary metal imported from other countries. As we did above in the case of capacity, let us look at the domestic primary aluminum production picture in the light of recent history. In 1950, 1.4 billion lb of primary aluminum was produced in the United States in reduction plants capable of producing 1.5 billion lb. The 1950 operating rate was, therefore, about 95 percent of capacity. For the full year of 1959 about 3.9 billion lb of primary metal was produced by the industry in its newly enlarged facilities, currently capable of producing 4.7 billion lb. The 1959 operating rate, therefore, was about 83 percent of installed capacity.



Aluminum slab entering the 168-in. breakdown mill at the new Kaiser Aluminum rolling mill at Ravenswood, W. Va. The mill is controlled from the glass-enclosed pulpit straddling the rolling table

The total aluminum supply picture is expressed by the following brief tabulation:

	(Million Lbs.)		
	1950	*Est. 1959*	*Percent Increase*
Domestic primary aluminum production	1,437	3,930	173
Primary imports	354	399	13
Secondary recovery	609	911	50

On the marketing side, shipments of all aluminum products in 1950 were 2.4 billion lb, and shipments were about five billion lb for 1959. The total consumption of aluminum in the United States, therefore, has also more than doubled during this period.

The aluminum industry withstood fairly well the effects of the recession in the latter part of 1957 and in 1958. For the year as a whole, 1958 aluminum industry shipments were only seven percent below 1957. One mill shape, extrusions, even showed an increase in 1958 over 1957. Shipments of aluminum products in the first quarter of 1959 were 45 percent above the same period of the previous year. The first quarter of 1958 was the low point in shipments for the industry. Shipments in the second quarter of 1959, due to increased consumption plus some buying based on the possibility of a strike in the industry, showed a 63 percent gain over the second quarter of 1958. Several major markets for aluminum, such as automobiles, trucks and trailers, residential construction, refrigerators, freezers and mobile homes experienced high production schedules in 1959, and the prospect is for continued high levels in production and demand.

Table I below summarizes our outlook for the principal aluminum markets through 1965.

Industry Recovered Rapidly From Recession

Three major characteristics will, in short, summarize the aluminum industry in the United States today. First, it is an industry which has tripled its primary production capacity in just nine years. Second, it has recovered rapidly from the 1957–58 recession; and, third all elements of the industry are engaged in very active programs leading toward the development of new markets and the

TABLE I

ESTIMATED TOTAL ALUMINUM SHIPMENTS BY MARKET
(Millions of Pounds)

Industry	*1948*	*1958*	*Percent Gain 1948 to 1958*	*1965*	*Percent Gain (Est.) 1958 to 1965*
Building	492	757	54	1557	106
Electrical	214	468	119	1446	209
Transportation	214	356	66	1302	266
Consumer durables	385	356	– 8	856	140
Containers and packaging	43	349	712	451	29
Machinery and equipment	214	227	6	384	69
Deoxidizing and destructive	85	194	128	225	16
All other uses	363	644	77	1681	161
Total commercial shipments	2010	3132	56	7900	152
Defense	128	468	266	500	7
Total industry shipments	2138	3600	68	8400	133

expansion of present markets—and among these are some of the nation's largest, most important industries.

Beyond these characteristics, however, are certain other related circumstances that are worthy of comment. One of these is the growing free world market for aluminum, and another is the great extent to which aluminum usage has penetrated in all of our metal working industries.

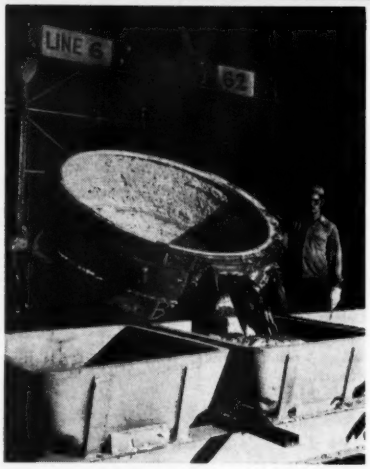
When we think and talk about world markets, we must also remember that we here in the United States are part of the so-called "world market." This part of that market has been receiving a good deal of attention from foreign producers and fabricators—particularly those on the European continent. We seem to detect an unfortunate unbalance here, for while we operate in this country with such reasonable controls that foreign fabricators can come in here with aluminum, pay the freight and the duty and still sell substantially below our domestic market price at substantial profit, how is that situation consistent with the very rigid controls, high tariffs, and restrictive quotas which we find when we go about our world marketing?

True, the reason behind this increasing under-priced importing is the low labor cost of these producers in Europe and Japan, and in many instances, direct or indirect subsidy by their respective governments. We have here a form of "double standard" of doing business—relatively open markets here for anyone who wants to come in and sell at lower price, based on very low labor costs, as against world markets for aluminum products closed to the United States.

That is inequity enough. We can look further and point out that these European producers are selling their aluminum products here in the world's largest metal-using market, toward the development of which they have contributed very little. We are not proposing any specific action for ourselves individually or for the industry collectively. These are simply comments on some characteristics of our business and our markets, which are today having a direct effect upon the financial success and stability of our respective businesses, and the security of thousands of employes.

Aluminum Sensitive to General Industrial Activity

Those of us who are fully integrated back to the mine talk a good deal about that integration and rightly so. What we sometimes overlook, although we deal with it every day, is the tremendous integration of aluminum as a material into the bulk of American production, both industrial and consumer. Aluminum is all around us. When you really think about it, it is actually difficult these days to produce and merchandise a modern product, either for industrial use or consumer markets, without using aluminum in one way or another.



Pouring molten aluminum into 1000-lb aluminum pig molds at the Chalmette reduction plant

We can look at this improving penetration, also, as one of the principal reasons why aluminum has shown itself very sensitive in recent years to changes in general industrial production levels. As shown again in 1957–58, aluminium shipments were among the first indices to show a downward turn as this well known recession came upon us. Aluminum shipments also were among the first to begin an upward movement as business began to recover.

As a consequence of this characteristic, our industry perhaps more than other metals, must provide reserve capacity with which to meet sudden peaks in demand if industry is not to be denied adequate supplies when it needs them most.

Finding New Markets Vital with Excess Capacity Available

The success of the aluminum industry in keeping its drastically expanded capacity operating at profitable levels, and the success of individual companies in maintaining earnings, depends directly upon sustained efforts to develop new aluminum markets. This does not necessarily mean completely new applications in which aluminum has never before been used. For instance, it may mean comparatively old applications which, through new methods of production, new alloys and new fabricating techniques, have become economically competitive.

Consumption Will Nearly Double by 1965

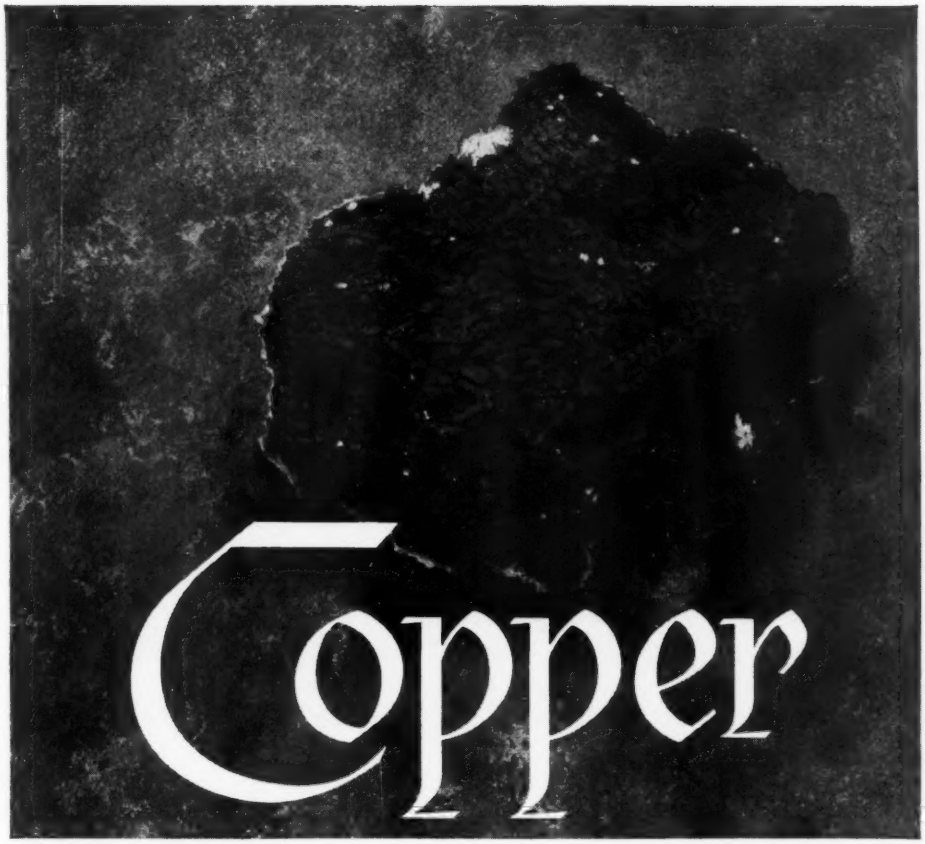
As indicated in the table above, our own estimate of total domestic aluminum consumption in 1965, an estimate made as long ago as 1955, is something over four million tons, or eight billion lb. Although in establishing a 10-year forecast, no one can be specific as to what consumption will amount to in any individual year during the period, it is true that consumption for 1959 falls pretty well on the rising trend line established by our forecast—in the area of 2.45 million tons, or 4.9 billion lb.

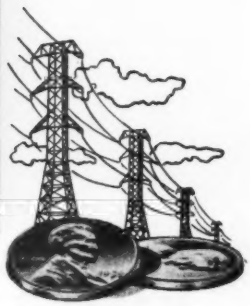
It would be our general impression that were we to develop another 10-year forecast during the coming year, extending our estimates to the year 1970, such a study would also show continuing growth of an order not far different from that of the 1955–65 forecast—in fact, not far different from the industry's overall growth rate since the turn of the century, during which time it has doubled, on the average, every ten years.

While there is a sizable proportion of the world's aluminum production facilities not in operation at the present time, this is an advantage in the development of markets and the encouragement of new large volume applications. Therefore, the present situation in world aluminum production capacity is not a static one. We cannot say that we have the capacity to meet our markets into the indefinite future. The free world's total aluminum capacity is actually far short of that which will be required over the coming near-future years.

There is growing recognition that because of phenomenal increases in scientific and industrial research, the acceleration in tempo of transportation and communications, the economic feasibility of constantly rising standards of living, and, not the least, the rapid growth in population—because of all these things, the world's extractive, fabricating and distributive industries are going to be pressed to the extreme to meet requirements.

With expansion so much a "built-in" feature in today's aluminum industry, we can be confident that when the new markets now under development require increasing amounts of metal, the industry will provide the increased capacity to supply it.



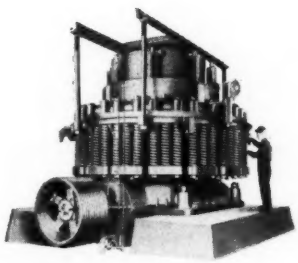


. . . symbol of money and power

The name *copper* is from the Greek κυπρος, Cyprus, one of the early sources of the metal. Copper has often been called "the common man's gold"—and has become a symbol of *money* due to its wide usage in the coins of many nations, as well as a symbol of *power*—since the greatest usage of copper has been as a conductor of electricity.

While native copper is the only metal found abundantly in nature, commercial production is supplied chiefly from various ores of copper, including chalcopyrite, chalcocite, cuprite and malachite.

Wherever these copper ores are processed—in Arizona, Chile, or the Belgian Congo—you'll find Symons Cone Crushers the leading choice among the world's prominent producers. For in copper . . . *as in all of the important ore and mineral operations around the world* . . . Symons Cone Crushers have consistently maintained their prominent position by efficiently processing large tonnages of finely crushed product at low cost.



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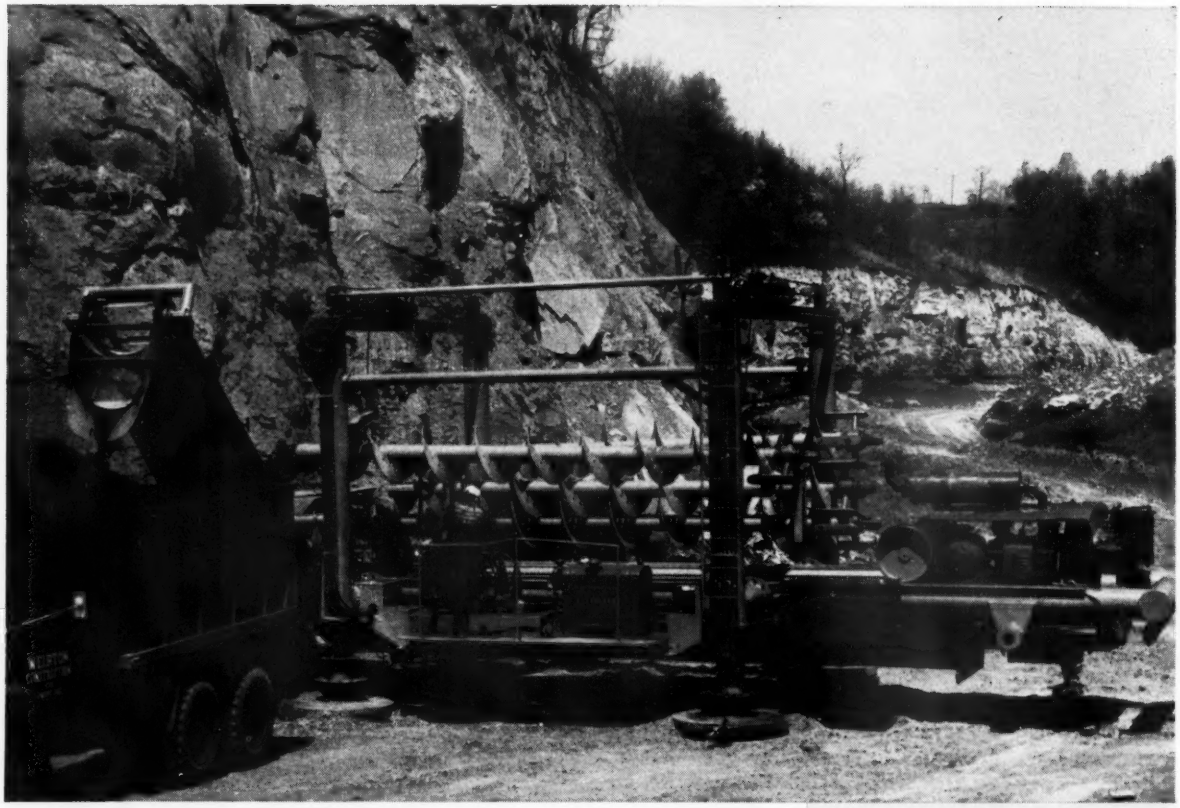

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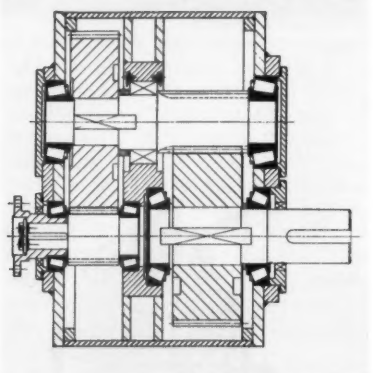

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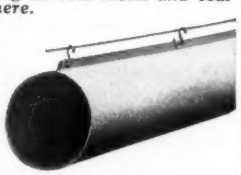

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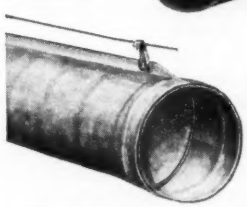

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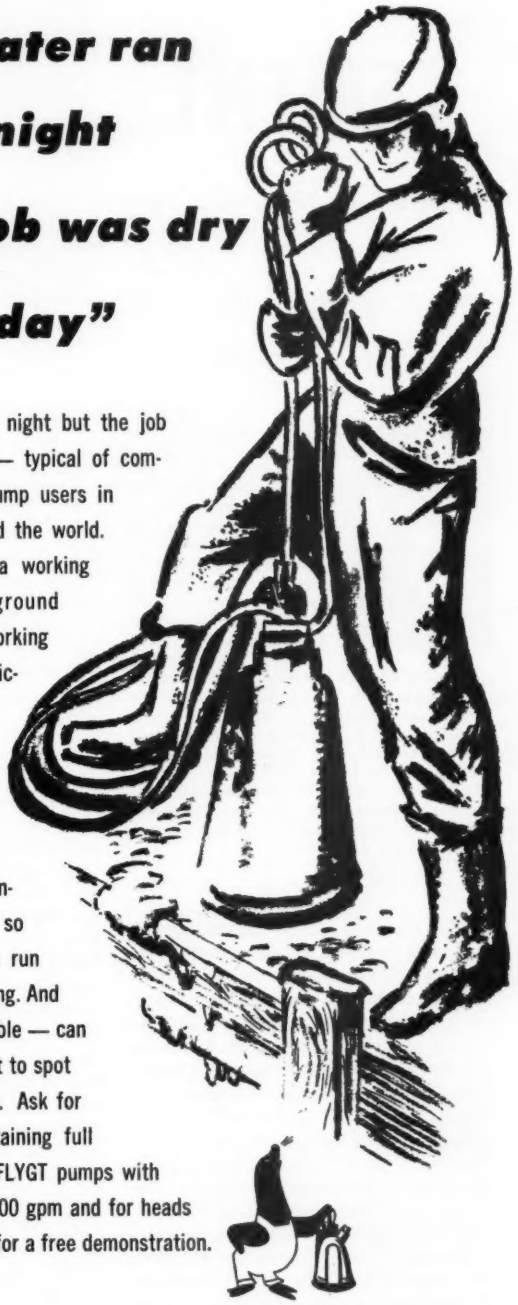

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CEMENT

Shipments in 1959 set a new record

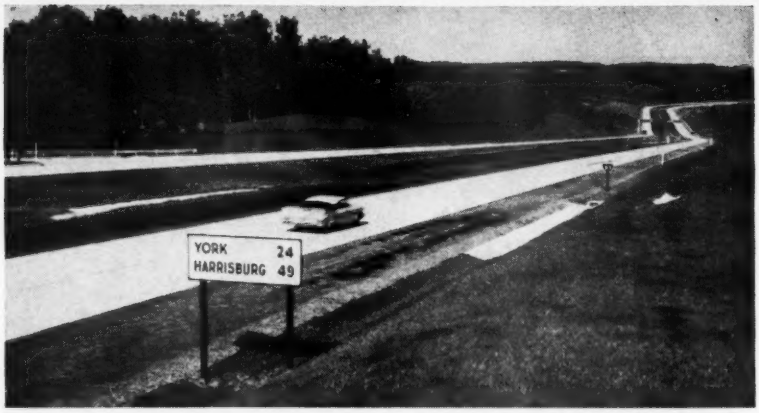
By ELLERY SEDGWICK, JR.
President
Medusa Portland Cement Co.

Ellery Sedgwick, Jr., graduated from Harvard College with a BS degree in 1932 and from Harvard School of Business Administration with MBA degree in 1934. Following graduation he was an assistant bank examiner with the Federal Reserve Bank of Cleveland before being employed by the National City Bank of Cleveland in the Investment Department. He was transferred to the Commercial Department in 1939. During World War II he served in the U. S. Navy and attained the rank of Commander before leaving the service in 1945. From 1946 to 1952 he was vice president, Commercial Department, National City Bank of Cleveland. In 1952 Sedgwick became president of Medusa Portland Cement Co.

PORTLAND cement shipments in 1959 reached a new record level of about 325 million barrels based on Bureau of Mines figures for the first 11 months. This represents an increase of 7.6 percent over 1958. In the three preceding years, shipments have been running at a level of between about 290 to 300 million barrels. This rise in shipments in the continental United States was primarily the result of a sharp increase in construction volume, especially residential and highway construction.

Prospects are for another satisfactory year in 1960. Economic forecasts of general business almost unanimously point towards a strong and rising economy throughout most of 1960 and cement shipments should benefit from this prosperity. On the negative side, a decline of new housing starts due to a shortage of mortgage money is expected and there will be a slackening in the pace of highway construction due to a cut-back in the amount of Federal aid funds available.

The Department of Commerce has forecast a two percent increase in the dollar volume of construction in 1960, which would produce a physical volume about the same as in 1959. The F. W. Dodge Corp. forecast, which has also been quite reliable in the past, predicts approximately equal dollar volume of building with a modest decline in physical volume. It is reasonable to believe, therefore, that the cement industry will experience another satisfactory year with shipments about at the level of 1959.



Among many important segments of the Interstate System completed during 1959 is the Baltimore-Harrisburg Expressway, Interstate 83. This road connects the Baltimore-Washington area with the Pennsylvania Turnpike

Construction During 1959

The construction industry experienced one of the most rapid growths in its history during 1959—the first substantial increase in physical volume since 1955. In the first three quarters of the year, the dollar volume was running 15 percent ahead of 1958 according to Department of Commerce figures. This rate slackened quite sharply in the final quarter as a result of the steel strike during the summer months and adverse construction weather throughout most of the nation in the fall. The final figures for the year as a whole are expected to show an overall increase of ten percent with a total of $54 billion compared with $49 billion in 1958.

By far the largest factor in this growth was an increase of some $4 billion in residential construction. Almost all other important segments of the construction industry, with the exception of industrial building, showed an increase over the preceding year. In percentage terms, public and private construction showed approximately equal gain, the largest increase in the public sector being in highways.

Construction Outlook for 1960

Both public and private construction should maintain about the same relative importance in 1960, increasing two percent and three percent respectively in terms of dollar volume. However, there are expected to be some important changes within individual segments of the industry. Residential housing is expected to decline some eight percent, whereas industrial construction is expected to expand substantially.

Highway construction which was a strong factor last year will undoubtedly slow down somewhat. Almost all other classifications of building, however, are expected to increase moderately in both dollar and physical volume. Inasmuch as residential construction accounts for a relatively small proportion of cement consumption, and with all other major categories of construction except highways almost sure to increase in 1960, cement shipments should be well maintained.

The Cement Industry

As previously indicated the latest figures available from the Bureau of Mines covering the first eleven months in 1959 show cement shipments 7.6 percent ahead of those for the same period of the preceding year. Assuming the same level of shipments in the final month as in December 1958, the total for the year should be about 325 million barrels.

Productive capacity of the industry continued to rise during 1959, and in November domestic capacity stood at nearly 410 million barrels annually, a 21 million barrel increase over a year earlier. The continued rapid rise in capacity is a source of concern to some in the industry. Others feel that some excess capacity is desirable to stimulate greater effort in promotion and exploitation of the concrete industry's vast potential markets.

Cement companies' published reports reflect a continued sharp in-

Typical of many spectacular concrete shell roofs being built throughout the United States is this grandstand roof at Scioto Downs racetrack in Ohio. Two more of these hyperbolic paraboloid shells will be built to complete the roof

crease in the cost of operation, primarily the result of unduly large wage increases granted in each of the past two years and the rise in price of almost all purchased materials. These circumstances, combined with sharply rising costs of replacing existing facilities, resulting in higher depreciation charges and inadequate price relief, have continued to narrow the profit margins of most cement companies.

Another concern of the industry has been the continued dumping of cement from abroad at prices which are obviously insufficient to cover the shipper's bare manufacturing and transportation costs. While this has been troublesome in certain areas, the volume is relatively small.

The Highway Program

One of the most important markets for cement is highway construction. The unprecedented highway construction program initiated by the Federal-Aid Highway Act of 1956 has had considerable impact on the cement industry along with many others. Because of the amount of time required to design modern roads and acquire rights-of-way—about two years on the average—the impact of this program on construction began to be felt only late in 1958.

However, in 1959 a financing crisis arose which threatened to halt the program completely. This crisis was due in part to a weakness in financing provisions of the 1956 Act and was aggravated by emergency anti-recession highway spending provisions of the 1958 Highway Act. The compromise financing arrangement finally incorporated in the 1959 Highway Act provides for considerably less federal-aid money in fiscal 1961 and 1962 than was authorized in the earlier highway acts. The actual reductions are from $3.425 billion to $2.725 billion in fiscal 1961, and from $3.1 billion to $2.925 billion in 1962. This reduction in federal funds, however, is expected to result in only a slight slackening of highway construction in 1960.

This is not to say that the confusion and lack of clear purpose evident during the long controversy over the 1959 Act is not cause for concern. But this legislation dealt primarily with interim financing of the program until the results of a number of comprehensive studies on highway costs and benefits are available in 1961. These studies will form the basis for a complete reevaluation of the program on a much sounder basis than has heretofore been possible. The most important of the studies is the $22 million National Road Test near Ottawa, Ill., which is evaluating various pavement and bridge designs and types and the cost of providing facilities adequate for various classes of traffic.

Although it is impossible to say at this time what these studies will show, it is unlikely that they will indicate that the present highway program is too ambitious. It is more probable that they will indicate the need for a larger rather than a smaller program.

Structural Uses of Concrete

Along with the highway program, the strongest growth factor for the cement industry, beyond the normal growth of construction, is an extension of the structural applications of concrete. Prestressed concrete, shell roofs, the ultimate strength design method, precast exposed aggregate wall panels and other decorative surface treatments—all are expanding the potential of concrete for structures. The industry is vigorously developing and promoting these and other improvements in the use of cement.

Prestressing. The best known recent development in the use of concrete is prestressed concrete. The prestressed concrete industry, which in the United States essentially began in about 1951, has already grown to some 300 plants with sales of something like $400 million in 1959. Major emphasis has been placed on bridge girders, and prestressing has extended the economical range of concrete bridges from spans of up to about 70 ft to include practically all bridges of major economic importance. As an example, a bridge now being constructed of prestressed concrete at Oneida, N. Y., spans 320 ft. This bridge would have been built of steel only a few years ago.

With initial success achieved in the bridge field, the prestressing industry is increasingly focusing its attention on building construction.

Prestressed floor and roof units have great and relatively undeveloped potential. In 1959, it is estimated that about 25 percent of prestressed sales were in building units. Since this field provides the greatest potental for growth, it many be expected that this percentage will grow rapidly. Prestressed concrete eventually may well assume the dominant role in floor and roof construction that concrete masonry has achieved in wall construction.

Shell Roofs. Although the principle of concrete shell roofs has been known for many years, it is only recently that shell design has been widely understood and used in this country. A shell roof gains its strength from its three-dimensional curved shape, on the same principle as an egg shell. By choosing the proper shape, an engineer can design a concrete roof only a few inches thick to span almost unlimited distances. In the past few years the growth in use of shell roofs has been spectacular; there are literally thousands in this country now. A large proportion of these roofs would have been built of other materials if shell designs had not been available.

No national figures are available on the total number of shells built but two examples will give an indication of their current popularity. In Seattle, a single engineering firm has designed 43 shell roofs in the last five years for construction in central and western Washington. In Wisconsin at least 22 shells were under design or construction at one time during 1959.

These examples are typical of the great interest in shells throughout the country. This interest should continue to grow in the future for two main reasons. First, shells can provide the most economical roof for a wide range of utilitarian structures. Second, they provide a powerful new medium of architectural expression that already has had great impact on the thinking of architects.

(*Continued on page 100*)

COAL RESEARCH—PART I

By JOHN MITCHELL,
Director of Research
and
JOHN C. QUINN,
Senior Research Chemical Engineer
Eastern Gas & Fuel Associates

A broad, world-wide survey of coal research and development activities, this review article has been broken into two sections. Part I describes the work carried on during the past year in the United States with regard to properties of coal, production and preparation, utilization as a fuel, and conversion to another form prior to end use. The second part, scheduled for the March issue, will cover the activities of a number of major research centers outside of this country

Two research men from Eastern Gas & Fuel Associates have cooperated in presenting a "bang-up" review of coal research activities during the past year.

John Mitchell, director of research for the company, obtained his B.S. degree from

J. Mitchell

J. Quinn

Glasgow University, Scotland. He has several patents in fuel technology and has authored a number of papers on coal research. In June 1947 he was chairman of the international Gordon Research Conference on Coal at Hampton, N. H. He is a member of the American Academy for the Advancement of Science and of several other technical societies related to the fuel industries.

Dr. John C. Quinn, Eastern Gas' senior research chemical engineer, is a graduate of both Stanford University and Massachusetts Institute of Technology. Professional experience covers process design work in the petroleum industry, teaching of chemical engineering, research in combustion, and metallurgical fuels research and application.

THE authors have endeavored to obtain as complete a picture as possible of the coal research and development activities carried on in 1959 in the United States. Some organizations, to a greater or lesser degree, did not make information available for practical reasons.

It was thought the scope of the survey could be usefully enlarged this year to cover the work of a number of major research centers outside of this country, not only for purposes of perspective but also to emphasize the community of interests in the broader world of coal. This portion will appear as Part II in the March issue of *Mining Congress Journal*.

At the outset, the authors would like to thank the many contributors whose cooperation made this article possible, with perhaps a particular feeling of appreciation for the contributors overseas.

Coal Properties

Structure and Chemistry. Babcock & Wilcox Co. was actively engaged in studies of the ignition properties of coal and other solid fuels, the nature of alkalis and chlorine as they occur in coal and lignite, and the presence and quantities of fluorine in coals.

Research at the Coal Research Laboratory, Carnegie Institute of Technology, is solely concerned with the structure and composition of coal. Studies are being made of the sorption of gases on coal and on polymers of known structure, degradation of various coals using the mild conditions of the molecular still, and of the conditions necessary for the polymerization of aromatic compounds, which might be similar to those occurring in coalification.

Illinois State Geological Survey is continuing its work on coal petrography. A heat-stage microscope is being utilized to study the thermal behavior characteristics of coal constituents. By very fine grinding and centrifuging, concentrated samples of various coal materials are being prepared for observation and special chemical analytical work.

The long-range paleobotany program involving the description of spores and other plant entities in coal and the use of spores in the correlation of coal seams has been continued, as has been the project on oxygen-containing structures in coal. The results of a study of weakly acidic structural groups in Illinois coals and in oxidized and/or carbonized samples of these coals were published. Experimental work was completed on the relationship of the solvent extracts of coal to its plastic properties as determined by the Gieseler plastometer.

The Department of Fuel Technology, Pennslyvania State University, is extending its work on the purification of bituminous coals by solution in aromatic oils as a means of obtaining more accurate information on the chemistry of the coal constituents (as well as finding methods of utilizing coal as a more direct source of organic chemicals). The effect of radiation on the physical and chemical properties of bituminous coal and coal by-products is under study, as are the chemical nature, physical structure, and distribution of ash in anthracite, and the grindability of coals (as related to physical and chemical structure).

The U. S. Bureau of Mines continued its systematic investigation of the composition and structure of American bituminous coals and lignites by petrographic, physical, and chemical methods. A new program, started in 1958, concerns the effects of radiation on the physical and chemical properties of coal. The microbiological reactions of coal were also investigated further, including the possibility of using bacteria or micro-organisms for sulfur elimination.

In addition, the Bureau carried on

fundamental research on the chemical and physical properties of anthracite. This included qualitative structural analyses and infrared analyses of the products resulting from the treatment of anthracite with nitric acid. The electrical characteristics of anthracite under the influence of electric and magnetic fields were investigated. Behavior was found to vary with volatile matter content and type of field. Analyses of anthracite samples exposed to neutron and gamma radiation in 1958 indicated that the exposure had induced structural changes in the coal. The neutron irradiated samples had lower electrical resistivity and higher resistance to grinding, while magnetic resonance data, obtained on the gamma irradiated samples, showed an increase in the free-radical content.

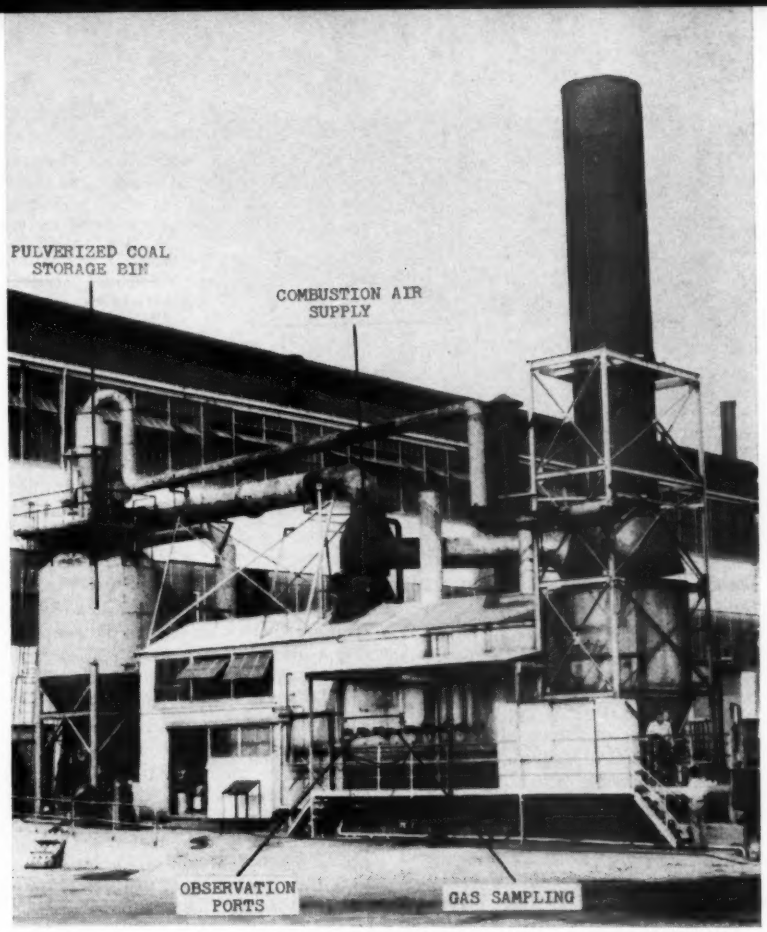
Virginia Polytechnic Institute reports studies of coal at high temperatures in oxidizing and inert atmospheres and also of the permeability of coal to gas.

Analytical Procedures, Testing and Standards. Committee D-5, Coal and Coke, of the American Society for Testing Materials, is the official group in the United States concerned with the development of standard methods for the sampling, analysis and testing of coal and coke.

Through the American Standards Association, Committee D-5 continues to participate in the work of the International Organization for Standardization in developing international standard methods for the analysis and testing of coal and coke. During 1959. the United States has been represented at meetings of three working groups and one subcommittee. Items which these groups considered were testing of coke, sampling of coal, preparation terminology, and lignites and brown coals. Many proposals have been reviewed by D-5 members in an effort to secure methods applicable to U. S. coals, workable in U. S. laboratories using equipment available in the United States.

Bituminous Coal Research, Inc.. has developed a rapid analysis method for pyritic sulfur which reduces analysis time from 48 hours by the standard method to less than two hours by the BCR method. Use of this method during 1959 indicates its application may be extended to total sulfur analysis. BCR also developed an improved furnace for Free-Swelling Index determinations which will be extensively tested.

At the request of lake coal shippers, BCR began work late in 1959 on the development of devices and techniques of sampling railroad cars.



Outdoor view of the 200,000,000-Btu-per-hour test tunnel at Babcock & Wilcox's research center

Bituminous Coal Research, Inc., and Pittsburgh Coke and Chemical Co. are jointly sponsoring a project at BCR on the development of a reliable bench-scale test to determine the degree of oxidation of bituminous coals.

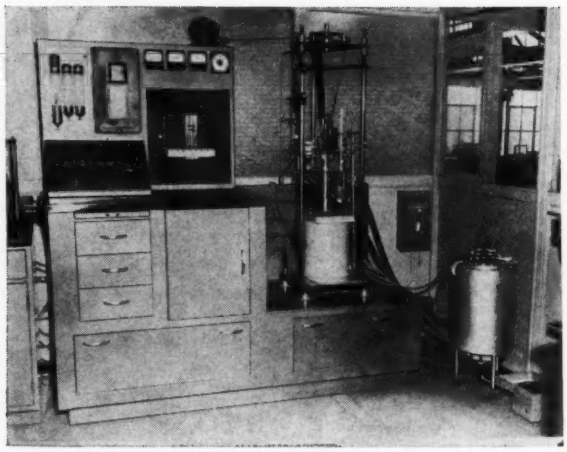
Combustion Engineering, Inc., is cooperating with ASTM in the development of better analytical methods for volatile matter, chloride and sulfur forms in coal, and in the standardization of calibration procedures for the adiabatic calorimeter.

Under a continuing project, the Illinois Geological Survey participated in a revision of ASTM methods for the determination of volatile matter, calorific value by the non-adiabatic calorimeter and ash fusibility. In addition, it participated in the development of new methods for determining sulfur in ash, mineral carbon dioxide and plasticity of coal by the Gieseler plastometer. It is reported that considerable progress was made in Committee D-5 on methods for mechanical sampling of coal, preparation of analysis samples and for the determination of calorific value by the adiabatic calorimeter.

U. S. Bureau of Mines continued work directed toward the development of satisfactory methods for the rapid routine analysis of coal ash and related materials. In cooperation with Committee D-5, and with the IOS, the Bureau has also continued its contribution to the evaluation and standardization of international systems of coal analysis and classification. A study was made of the application of proposed tests for the classification of low rank coals and three different methods for the determination of phosphorus were investigated.

The Micum test is used extensively in European countries to evaluate the mechanical strength of cokes and is now under consideration as a Standard Recommendation of the ISO. In connection with this proposal, the Bureau of Mines initiated a series of tests to correlate the ASTM Tumbler and Micum test methods. Similar data were also contributed, on a voluntary basis, by the Research Laboratory of Eastern Gas and Fuel Associates.

West Virginia University is seeking to determine, by means of factorial



Viscosimeter for use in slag studies at Babcock & Wilcox Company's research center, Alliance Ohio. The slag tapping characteristics of fuels such as lignites and sub-bituminous coals were studied in connection with their utilization in boilers and gasifiers

design, the optimum temperature and time for coal ash analysis.

Coal Production, Preparation and Handling

Reserves. The Alabama State Mine Experiment Station is continuing its accumulation of proximate analysis and other test information on coal beds and districts of minor importance in the state.

The Illinois State Geological Survey continued its program to map strippable coal reserves in various categories of overburden, thickness and reliability. A revision of the mined-out-area maps of the state has been completed as of 1959. With regard to Pennsylvanian geology and coal resources, a report on Douglas, Cole and Cumberland counties, Ill., was published. Studies of Pennsylvanian strata other than coals have been continued because of their relation to the variation and minability of coal deposits. The system of classification of the coal-bearing Pennsylvanian strata was re-examined and a new system proposed. A correlation chart has been compiled showing the relationship between coals and other key strata in Illinois with similar strata in Indiana, Kentucky and Missouri. The program of diamond-drill core logging was continued. Approximately 20,000 ft of core was described from drill holes representing over 100,000 ft of drilling. The cores were sampled selectively for the Survey files.

At the University of Kentucky, the Kentucky Geological Survey continued its mapping of coal resources: In the southeastern portion of the state, the quadrangles Scalf, Beverly, Pineville, Balkan, Varilla, Middlesboro North, and part of Middlesboro South have been completed; in the eastern counties, the Kentucky and U. S. Geological Surveys are cooperating in this work; in the western field, the Kentucky Survey is working cooperatively with the Tennessee Valley Authority, giving special emphasis to coal reserves, the results to be published by the Kentucky Survey. The Department of Mining and Metallurgical Engineering continued studies on the analysis and quality of clays associated with coal seams. In connection with its renewed interest in low-temperature carbonization, a file of coal analyses is being assembled by seams for a study of uniformity.

As part of the continuing investigation of Ohio's coal reserves, the Ohio State University Engineering Experiment Station, in close cooperation with the Ohio Geological Survey, is conducting a program to determine the physical and chemical properties and washability characteristics of the Lower Kittaning No. 5 coal bed.

The Ohio State Geological Survey carried on a mapping of coal beds and associated strata in Monroe, Washington, Wayne, Stark, Licking, Hocking, Fanfield, Knox and Gallia Counties., The investigation of the petrography of the Lower Kittaning No. 5 coal bed was continued, including a detailed study of various size and specific gravity fractions to determine the petrographic variation caused by preparation techniques. Fossil spore investigations, useful in bed correlation, were continued on Lower Kittaning coal; similar work on Meigs Creek (Sewickley) coal was begun.

Tennessee Valley Authority continued its investigation of the location, extent and minability of remaning coal reserves within its coal supply area. In 1959 an investigation of coal resources in northern Tennessee was largely completed; investigations in the western Kentucky coal field were expanded and work begun in the southeastern Kentucky area.

The Northwest Experiment Station of the U. S. Bureau of Mines, located at the University of Washington, reports active exploration and prospecting of undeveloped coal areas in the State of Washington with coking coal and steam coal deposits receiving the most attention. Two power companies jointly are exploring sub-bituminous deposits in the vicinity of Centralia, Wash., and, to date, have announced a reserve of 70,000,000 tons minable by stripping. Another group is investigating the feasibility of a 300,000-kw steam plant in the Roslyn, Wash., area based on mining bituminous coal underground.

In 1959 the Bureau's major effort in the Alaskan exploratory work was directed toward moving the drilling equipment into the Beluga River area and drilling of six boreholes, five of which intersected coal beds, each of which exceeded 20 ft in thickness.

The Virginia Polytechnic Institute reported projects on the sub-surface stratigraphy and tectonic framework of sedimentation of the Lee Formation in Buchanan County, Va., and on the correlation of Pocahontas coals in western Virginia and West Virginia.

Stratigraphic investigations were carried on by the West Virginia Geological and Economic Survey in a portion of Grant and Tucker counties, W. Va., in order to correlate and determine the extent of the coals in this area. The existing geologic maps of the region were found to be essentially correct.

Mining. Consolidation Coal Co., through its Lee Engineering Division, continued development of various mining and transportation machinery. New developments found widespread acceptance in mines of the parent company as well as throughout the mining industry. Improved explosives of the ammonium-nitrate type were the goal of extensive research and development efforts on the part of the Hanna Coal Division. This work is particularly related to the large stripping operations in eastern Ohio which require specific types of explosives.

The Illinois State Geological Survey continued studies of geologic properties contributing to the quality of coal-mine roof by means of evaluating diamond-drill core.

The Mellon Institute Fellowship on Mine Acid Control, sponsored by the Coal Advisory Committee to the Ohio River Valley Water Sanitation Commission, is now in its thirteenth year

of operation. Much has been accomplished on fundamentals of this stream-pollution problem but complete solution is far from realization. Studies are in progress on experimental mine operation, on impoundment of water, on pumping procedures, and on mine flooding.

Penn State's Mining Department carried on a project dealing with underground stress measurement and instrumentation for the control of roof and bottom conditions.

Evaluation of foreign hydraulic mining techniques, as regards applicability to American mining conditions, was continued by the U. S. Bureau of Mines with actual tests at the mining site. The equipment was tested for operability and capacity; preliminary tests were encouraging.

The Bureau began a study of mine degasification for the purpose of developing methods for exhausting methane from gassy mines or coal beds in advance of actual working. A literature survey was completed and preliminary field tests were started.

New attention was devoted to acid mine water formation and the development of control methods. A study of past work led to the formulation of a research program for establishing, on a laboratory scale, the mechanism of acid formation in coal mines. Attempts will be made to relate the laboratory data to on-site conditions.

A research program dealing with vertical, hydraulic transportation of solids was accelerated. Settling velocities were determined for coal, slate and rock of different sizes, shapes and specific gravities. Pumping tests were conducted in an experimental hoisting system to determine optimum-flow velocities and solid-water concentrations in the vertical transport of solids. An alternate method will be tested in which solids do not pass through the pump but are introduced into the system by means of a lock-hopper feed mechanism.

The Bureau cooperated with an anthracite producing company in establishing a full-face, mechanical mining project in a thick, steeply-pitching seam. This project inculdes the development and use of a continuous mining machine for advancing coal gangways, a large-diameter boring machine for driving ventilation and escapeways, and yielding-arch steel supports for roof control. Outstanding production capability was demonstrated with production of 700 tons of run-of-mine coal per day (27 tons per manshift) being attained in the experimental section of the mine. However, difficulty has been encountered with roof control and, at present, work is directed toward overcoming this problem.

The face was established at the longwall mining project and a continuous mining machine imported from Germany (the Eickhoff drum cutter-loader) was given limited tests. In these preliminary tests, the machine demonstrated its ability to cut anthracite. However, an unsatisfactory roof condition developed during the tests and, from practical considerations, it was decided to select a new location where the machine could be evaluated under more favorable geologic conditions.

At the University of Kentucky, the Department of Mining and Metallurgical Engineering has begun a study of the possibility of substituting heat-treated roof bolts for as-rolled bolts of larger diameter.

Virginia Polytechnic Institute reported projects on clay minerals in roof shales and the effects of such minerals upon the action of the shales in a coal-mine roof, the strength of coal-mine pillars, rock bursts or bumps in coal mines, drainage and recovery of methane from coal beds, the permeability of coal to gas, the structural strength of coal-mine floors, the application of industrial engineering to coal mining, and the effect of re-use upon the strength of roof bolts.

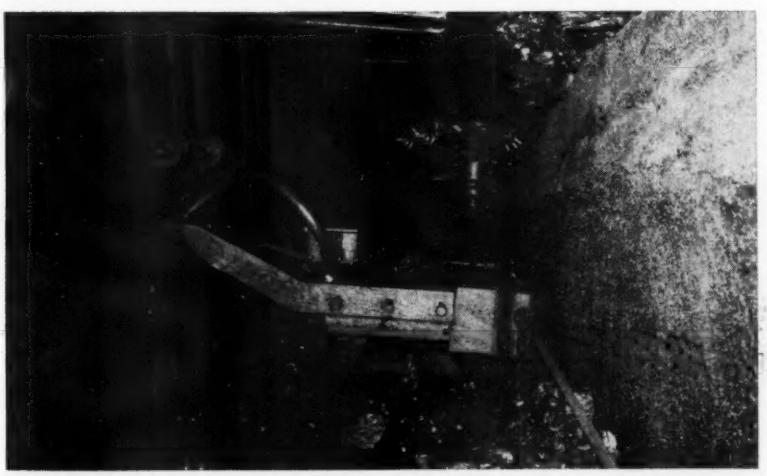
At West Virginia University one of the research programs includes a study of devices and methods for suspension roof support, the possibility of degasification of the coal in advance of mining, the properties of sulfide inclusions in coal beds with relation to the operation of continuous mining machines and other equipment, the electronic measurement of stresses in the strata as induced in mining, and the analysis of rock failure.

Coal Preparation and Handling. The work of Bituminous Coal Research, Inc.'s Mining Development program, formerly carried out in Huntington, W. Va., was transferred to BCR's Columbus, Ohio, laboratory. Work relating to higher productivity in mining equipment and methods is continuing. Field tests on a continuous moisture determining device for coal preparation plants were successful during a full year's use.

The Illinois State Geological Survey reported progress in eliminating the problem of the staining of commercially prepared coal, particularly that occurring on oil treated stoker coal. The study of the influence of mining and preparation on the petrographic composition of the various sizes of coal was completed.

Limited investigations have been continued by North American Coal Corp. on the production of low ash and low sulfur coals.

The Department of Mineral Preparation, Pennsylvania State University, carried out a 96-plant survey of all preparation plant equipment in the Pennsylvania bituminous field to see if there was a correlation between type of equipment used and geographical location, and between equipment type and plant capacity. A number of coal preparation plant slurries were also analyzed to determine the amount of coal being lost in the slurry bleed-off. Other studies covered the mechanism of flocculation



The Eickhoff shearer-loader, a continuous mining machine imported from Germany, demonstrated its ability to cut anthracite in preliminary tests at a Pennsylvania mine. Note skid, safety-rope yoke and cable support. The U. S. Bureau of Mines cooperated with an anthracite operator in this project

of coal slimes and the influence of such variables as type of flocculent and size consist, and the utility of the hydro-cyclone for fine coal cleaning. In the latter, particular attention was given to the effects of pulp density and inlet pressure on the efficiency of separation and capacity. An investigation was also made of the Convertol Process to determine the effect of solvent structure on the solubility characteristics of coal. A number of pure organic compounds were used.

In March 1959 the Pittston Co. opened its new testing and research laboratory and proceeded with an investigation of problems concerning the mining, preparation and use of coals. A program on recovery of fine coal from plant wash water discharge resulted in an installation of froth cells which are capable of producing substantial quantities of fine coal from this source.

Coal preparation studies of the U. S. Bureau of Mines are concerned with a variety of washing techniques, including dense-medium separators, flotation units, jigs, and cyclones. This work continues with the objective of developing information leading to improved efficiency.

The study of kerosene and conventional froth flotation processes continues with present attention being given to their mechanisms and the factors influencing flotation rates.

A dense-medium cyclone pilot plant was built and tests were made to explore the possibility of cleaning fine coal without desliming, using a procedure wherein the conventional drain-and-rinse screens are eliminated and only magnetic separators are used for the recovery of medium (magnetite).

The Bureau's work on the recovery of fine coal from washing water has been concerned with three phases: The investigation of flocculation as a means of improving the vacuum filtration of coal slurry (completed), the investigation of the efficiency of the sieve bend, and a comparison of these results with those obtained by vibrating screens.

In conjunction with its coal-preparation investigations, the Bureau outlined a program for the performance testing of equipment used in commercial operations by means of an actual survey of preparation plants.

A study was made of the pulverization characteristics of lignite and the power requirements, using an experimental impact-type pulverizer. Data were accumulated to establish the influence of moisture content on power requirements and on pulverization characteristics and to explore the conditions of optimum efficiency and cutoff points.

Washability studies were made of several anthracite silts to determine the feasibility of using conventional cleaning devices for their recovery. Studies on the relationship of particle size to ash content showed that fractions containing less than 0.5 percent ash could be separated from each of the anthracites investigated. Tests were also conducted on preparing small sizes (Buckwheat Nos. 1 and 2) in dense-medium equipment. A radiation-source type instrument was used to provide the precise control of the media needed in preparing the finer sizes. Performance of an air-swept conical ball mill in producing ultrafine anthracite was evaluated.

Efforts continue to develop a method for preventing the freezing of lignite. It was found that the addition of approximately 300 lb of partially dried lignite per ton of moist product, with a moisture content of approximately 15 percent, was an effective freezeproofing method. An industrial organization plans to use this method.

Tests using gas-fired radiant heat to dry filter cake while on the filter indicate that improved drying takes place. An economic study indicated this method to be less costly than conventional thermal drying.

The Bureau's survey of the preparation characteristics of American coking coals was continued.

Sponsored by the University of Washington, research in coal preparation with emphasis on the fine sizes is continuing at the U. S. Bureau of Mines Experiment Station in cooperation with the School of Mineral Engineering.

The dense-medium cyclone, developed originally at the Dutch States Mines, is being investigated in a new five tph pilot plant.

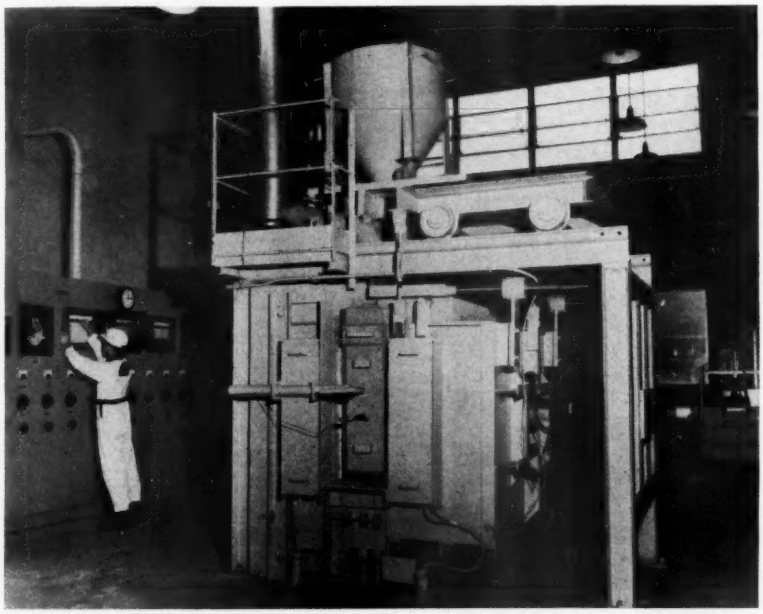
To minimize stream pollution and improve the recovery of the fine coal sizes, an investigation of some of the new, high-polymer flocculating reagents has shown significantly higher filtration rates. Clay composition had a major bearing on the filtration properties.

Virginia Polytechnic Institute reports a project on the washability of Virginia coals.

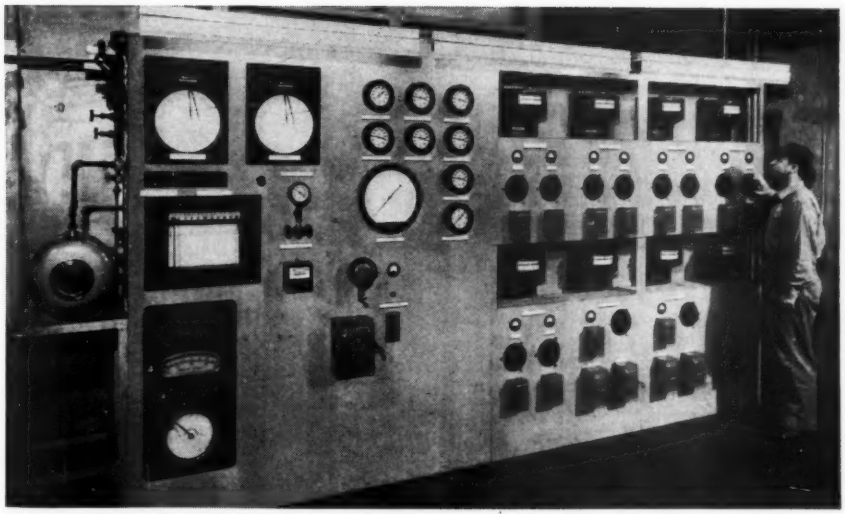
The Engineering Experiment Station of West Virginia University reports projects on the cleanability of West Virginia coals, prediction of power requirements for crushing, and rheology studies of coal-water slurries.

Utilization of Coal as a Fuel

Babcock & Wilcox activities include fuel utilization and equipment development. Receiving attention were the high temperature reactions of ash and their relation to ash deposition and high temperature corrosion, the evolution of sulfur in fuel to SO_2 and SO_3, atmospheric pollutants and flue gas analyses. The slag tapping characteristics of fuels such as lignites and sub-bituminous coals were stud-



Clinchfield Coal Company's new laboratory includes a pilot-scale test oven (foreground)



Work on the production of high Btu gas from coal, sponsored by the American Gas Association, is continuing at the Institute of Gas Technology. View shows a control panel at the Institute's hydrogasification pilot plant

ied in connection with their utilization in boilers and gasifiers. New means are being sought to characterize wall slags from the standpoint of ease of removal. Thermodynamic studies of reactions between combustion products and the inorganic constituents of coal are going forward. A program is in progress to develop a pulverized coal burner with a capacity more than twice that of present designs as well as a new larger capacity pulverizer. Vibration cleaning of heat absorbing surfaces is also under development.

Bituminous Coal Research, Inc., continued its equipment development program which has led to successful commercialization of two package-type automatic steam generating plants for commercial and small industrial installations as well as two types of residential heating units. In addition, BCR is continuing its bench-scale, pilot-scale, and full-scale research on the factors affecting plasticity of bituminous coals in relation to their performance on stoker grates and to the design of combustion equipment.

The Association of Edison Illuminating Companies, the Edison Electric Institute, and the coal industry jointly sponsored two projects at BCR for the control of sulfur oxides from power plants. The work is directed both at the control of atmospheric contaminants in flue gases and at sulfur reduction in steam coals. The work involves the development of fundamental information on the nature and occurrence of sulfur in bituminous coals and the development of new approaches to the problem of sulfur removal.

BCR's Locomotive Development Committee loaned the U. S. Bureau of Mines its entire coal-burning gas-turbine test plant for the purpose of developing this type prime mover for stationary plant applications. BCR will contribute financially to this project in 1960.

Combustion Engineering, Inc., is investigating coal composition as it relates to deposit formation and high-temperature corrosion in boilers. Laboratory studies indicate deposit-type wastage is due to formation of complex alkali iron sulfates, molten within the operating range. In cooperation with West Kentucky Coal Co. and Electric Energy Inc., the feasibility of removing from coal those elements which cause high-temperature corrosion is being investigated. Also under study is the relation of coal abrasiveness to pulverizer wear.

Relative to air pollution studies, an improved titrametric method for the simultaneous determination of SO_2, SO_3 and HCl in flue gas is being developed.

Research at Consolidation Coal Company's Research and Development Division continues to include pipeline transportation and processing of coal.

The Illinois State Geological Survey has extended its investigation of the mineral matter of coal and its effect on boiler tube deposits and corrosion. Attention is being given to the varieties of sulfur in coal.

Norfolk and Western Railway Co. has developed an efficient and economical coal-fired, package type, steam generator applicable in the 50 to 300 bhp range. Its simplified construction makes it competitive with equipment fired by oil or natural gas.

A stoker project at the Department of Fuel Technology, Pennsylvania State University, is concerned with the further development and adaptation of a commercial-size installation for the effective combustion of small size bituminous coal. Other efforts are directed toward obtaining a correlation of laboratory combustibility tests of Pennsylvania bituminous coals with actual plant combustion performance, investigating the thermal ignition characteristics and burning rates of finely divided solid fuels, and establishing a better understanding of the processes involved in the thermal decrepitation of anthracite.

The U. S. Bureau of Mines continued studies of pulverized-coal flames, reactions of mineral matter at high temperatures in combustion gases, and methods for alleviating corrosion of boiler tubes. It also continued efforts to develop information on furnace performance and extended its work on a probe for measurement of radiant heat flux.

As previously noted, the Bureau signed a cooperative agreement with the Locomotive Development Committee of BCR that allowed the transfer of the coal-fired gas turbine plant previously located at Dunkirk, N. Y., to the Bureau's Morgantown, W. Va., station. A four-step program was drawn up by the Bureau with the objective of designing blading that would be subject to minimum erosion.

In a related project, a study was made to determine whether ultrafine sizes of coal, if properly burned, could be used in the gas turbine with minimal erosion of blades. A method of uniformly feeding ultrafine coal

at rates from one to five lb per minute was developed and used in preliminary combustion tests with a subbituminous coal.

Research progressed on producing an agglomerate anthracite metallurgical fuel. A series of tests are being conducted in a simulated metallurgical stock column to determine the effect of briquet size and shape on the pressure drop in a fuel bed.

Tests of calcined anthracite were concluded with a series of runs in a commercial foundry cupola. Although metal temperatures did not meet completely the requirements of many commercial foundries, the fuel performed satisfactorily when melting iron for heavy sectional castings.

Virginia Polytechnic Institute reports a project on the use of powdered coal as a fuel in a piston engine. The coal was substituted for part of the regular fuel in a small diesel engine.

Conversion of Coal

Carbonization. Consolidation Coal Co. worked on further improvements in the quality of chemicals produced at the company's subsidiary, Pitt-Consol Chemical Co., and continued its development of new markets for acids and thiols.

Eastern Gas and Fuel Associates completed an extension of its Research Laboratory at Everett, Mass. In line with its objectives, Eastern's laboratory staff conducted an active carbonization investigation program of movable-wall oven, sole-heated oven, and quality oven testing for the evaluation of coals and coal blends. Considerable effort has been devoted to both pilot-scale and plant-scale tests for the purpose of further improving the quality and performance of foundry coke. Completed were final full-scale evaluation tests using 100 percent ferro coke in Eastern's blast furnace. These tests firmly established the ferro coke process as a simple, workable, and economical method for utilizing blast furnace flue dust.

The Illinois State Geological Survey completed a study of the effects of blending medium-volatile eastern coals of 21–27 percent volatile matter with Illinios coals for the production of blast furnace coke. It was concluded that the medium-volatile coals of the type studied may be used advantageously in blends with Illinois coals to produce coke of good metallurgical quality.

Weathering tests, conducted with Illinois coal stockpiled throughout the summer and fall months, showed no significant change in coke properties due to weathering of the coal. Similar tests on winter stored coal are continuing.

Pilot tests with mixtures of petroleum coke, Illinois, and low-volatile coal showed that good quality coke could be produced. Fine pulverization of the petroleum coke improved the coke structure.

The new Coal Carbonization Research Laboratory of Island Creek Coal Sales Co. was put into operation the past year. Its equipment and objectives were described in a paper presented before the American Coke and Coal Chemicals Institute in October.

Work is continuing on the evaluation of metallurgical fuels for the steel industry. Economic studies on the cost effects of ash and sulfur have been published.

The research reported in AIME paper, "Continuous Coke Production on a Water-Cooled Grate Stoker", has been continued on larger-scale equipment of different types in cooperation with industrial firms.

Koppers Company, Inc., investigated the effects of the pre-heating of high oxygen coals before carbonization on the properties of the resultant cokes. Preheating was done with superheated steam and carbonization carried out in the movable-wall laboratory test oven. Improvement in coke quality was obtained. Additional advantages claimed, for the two patented systems of charging described, were elimination of the need for a larry car and strong supporting roof structure, removal of the storage bin from the line of batteries, and modification of the handling system.

The Mellon Institute, under a continuing Fellowship sponsored by U. S. Steel Corp., is carrying on further studies on synthesis of new and useful derivatives of coal chemicals. Reactions and processes which yield products of possible commercial utility have been under investigation.

North American Coal Corp. has continued its limited investigations on carbonization, gasification, and hydrogenation of coal.

At Ohio State University, the Engineering Experiment Station carried on low and high temperature carbonization studies with emphasis on the development of a reliable small-scale assay test method for predicting the performance of a coal during carbonization.

The Pittston Co. is investigating the variability in coking characteristics of various coals. This is being carried out in the carbonization section of Pittston's new testing and research laboratory, which includes bench test equipment and pilot-size sole heated and movable wall ovens. The changes in carbonizing characteristics of coals subjected to controlled oxidation are being studied. This will be correlated with stockpiling problems at industrial sites. Although an investigation of European claims that Arnu and other small-scale tests give accurate assessments of the coking properties of coal has thus far yielded negative results when applied to American coals, the tests are being continued.

Southern Research Institute erected a pilot plant for fluidized carbonization of coal and is now obtaining engineering design data.

Work on the utilization of tar from low temperature carbonization of Alabama bituminous coal has been completed. The program was sponsored by Alabama Power Co. and its affiliate, Southern Services, Inc., in the interest of finding a means of reducing the cost of solid fuels.

Since 1950, Texas Power and Light Co. has participated in a cooperative agreement with the Bureau of Mines at Denver for research on Texas lignite. Further utilization studies have been carried out by Battelle Memorial Institute on low-temperature lignite tar produced in the prototype carbonizer located at Rockdale, Texas.

The Bureau of Mines studies included coking coal reserves, the properties of coking coals, and the mechanism and kinetics of coal carbonization. Attention was directed to the effect of cleaning on the expansion characteristics of selected coals, and the effect of fluidity on coking. The study of the thermal decomposition characteristics of high molecular weight materials was continued to establish the mechanism of tar formation and cracking.

Carbonization assays of coals and lignites of a wide range of ranks are also conducted as part of the Bureau's research program. The relationship of coal quality to assay yields is being studied by statistical techniques.

The carbonization assay procedure used at Denver was modified to provide for carbonization under pressure (at 100 psig). Preliminary tests indicate that higher char and gas yields and lower tar yields were obtained from lignite and sub-bituminous coal than were obtained at atmospheric pressure.

A technique that may permit the fluidized carbonization of coking coals in low-density beds, without preoxidation or heavy char recirculation,

was evaluated in preliminary pilot-plant runs.

Cooperative studies with industry were also continued on the possibility of producing metallurgical carbon from lignite chars. The Bureau's tests suggest that satisfactory briquets made of char and pitch could be produced.

Research on low-temperature tar was directed to two phases, separation and characterization of tar components, and upgrading and utilization of tar fractions. Development of assay procedures for low-temperature tar and tar distillates continued. In the upgrading work, the effects of operation variables on the catalytic dealkylation of a model compound, para-cresol, were studied in a laboratory unit. These studies include (1) separation of tar acids from distillate oil (using monoethanalamine), (2) dealkylation of tar acids, (3) separation of neutral distillate oils by solvent extraction into aromatics, olefins, and saturates, and (4) batch hydrogenation of tar fractions.

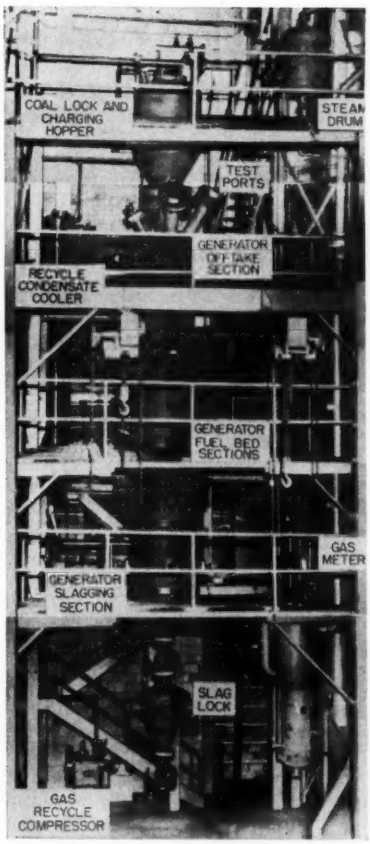
U. S. Smelting, Refining and Mining Co. has pilot tested a coking process capable of producing strong, high temperature coke in the form of pellets, from either coking or non-coking coals. Substantial amounts of by-product tar and an off-gas containing more than 80 percent hydrogen are also obtained.

The Department of Fuels Engineering, University of Utah, carried on a fundamental study to determine which chemical bonds disappear and what new chemical bonds are formed during coking. During carbonization of high volatile bituminous coal, samples of coal and of char at various stages of heating are examined by means of infrared spectrophotometry.

Research is now being conducted to determine the yields and quality of gaseous and liquid products as well as the char and coke produced when various high volatile bituminous coals from the intermountain west are subjected to different heating programs.

The Department of Fuels Engineering also reports that it assisted industry in developing a new technique for producing metallurgical grade coke from the high volatile bituminous coal.

West Virginia Geological Survey completed a study of the petrographic composition of the No. 2 Gas coal from an area in southern West Virginia for the purpose of relating variation in coke strength with composition. The Survey also reports that a petrographic study is being made of



The U. S. Bureau of Mines laboratory in Grand Forks, N. D., is working on the gasification of lignite with oxygen in a fixed bed using a slagging gasifier

sized coal received from another department that is investigating the dielectric constants of the same series of samples. Objectives of the combined program are to provide information on the concentration of petrographic constituents in the different size ranges of various coals, the relationship between petrographic composition and dielectric constants of the coals, and the effect of all these factors on the quality of the coke obtained.

The West Virginia University Engineering Experiment Station, under a Weirton Steel Co. Fellowship, reported work on physical properties of some bituminous coal and coke specimens. In a cooperative program with the Bureau of Mines, studies were made of the reaction kinetics of the hydrocracking and thermocracking of lignite tar fractions and the separation of olefins from saturates found in neutral oil in low temperature lignite tars.

Coal research at the Natural Resources Research Institute, University of Wyoming, has been concerned principally with research on upgrading or conversion of non-coking coals into forms or products of greater market value. An increasing demand for new sources of reducing carbons (coke) for a growing western metallurgical and phosphorus industry has given impetus to research directed toward production of metallurgical coke substitutes. Synthetic "coke" has been prepared from non-coking coals by charring, briquetting, curing and recarbonizing the char briquets. Reactivities of chars to oxygen and carbon dioxide are determined to study the influence of volatile matter, particle size, surface area and pore structure on reactivity. Fundamental research on the surface properties of activated and unactivated carbons, cokes, chars and coals is in progress.

Gasification. Work on the production of high Btu gas from coal, sponsored by the American Gas Association, is continuing at the Institute of Gas Technology. Two process routes are: Methanation of synthesis gas and direct hydrogenation of coal. There are now two pilot plants in operation to obtain process and design data.

Southern Research Institute, in a project for Alabama Power Co., is continuing to review the literature on underground gasification of coal.

The U. S. Bureau of Mines Laboratory in Grand Forks, N. D., is working on the gasification of lignite with oxygen in a fixed bed using a slagging gasifier.

In a cooperative program with the Atomic Energy Commission, the Bureau continued testing and developmental work on the use of nuclear heat for coal gasification. Efforts have been directed to the development of high-temperature technology for nuclear reactors capable of heating gases to 2500° F, and to the construction of heat exchangers to transfer this heat to process streams in the same temperature range. The induction-heated simulated nuclear reactor (ISR) and heat transfer loop constructed by the Bureau were used in tests with helium as the heat transfer medium. The Bureau is now designing a heat exchanger (gasifier) that will use the heat from the recycled helium to gasify coal.

The Bureau continued its study of the mechanism of the steam-coal reaction. Work is also progressing on the gasification of coal-water slurries in an externally heated tube-coil reactor. A series of runs indicated that chars of low-rank coals were not as

reactive with steam as the respective raw coal. Associated work on feeding the pilot plant gasifier included work on coal-water slurry feeding and steam pickup feeding.

With the Bureau of Mines, West Virginia University is also making a fundamental study of the variables in the gasification of steam-coal mixtures as well as investigating the heat transfer characteristics of coal-water slurries and steam-coal mixtures.

In a new program, the Bureau is planning to explore the possibility of oxidation of reactive coals in water at temperatures to 700° F for the production of synthesis gas or a low Btu fuel gas (for gas turbines) to produce electric power.

The Bureau's underground gasification experiments were suspended in 1959. Evaluation of the data obtained from the series of experiments at Gorgas, Ala., and from operations abroad, indicated that underground gasification is not competitive at this time with conventional mining.

Results of a commercial-scale gasification test by the Bureau provided the basis for a detailed engineering study on the technical and economic feasibility of producing pipeline gas and hydrogen from anthracite.

Hydrogenation. The U. S. Bureau of Mines is studying coal hydrogenation in the laboratory, and on bench and pilot-plant scales. In the laboratory, attention was directed to catalyst testing and evaluation. Hydrogenation of coal in the presence of sodium hydroxide in water was studied further in experiments on Rock Springs, Wyo., coal involving the effects of caustic concentration and hydrogen pressure on conversions and yields of oil and gas.

Hydrogenation of coal was studied on bench scale in both continuous and semi-continuous units. Information was obtained on equipment design, and on the effect of hydrogen pressure, temperature, residence time, and feed material. The latter included coking and non coking coals and a char. (No liquids were produced from the char).

Earlier Bureau pilot plant experiments on Rock Springs coal, using molybdenum catalyst, were extended. Catalyst recovery was investigated, as was the use of other lower cost catalysts, such as iron.

Process design studies have been completed by the Bureau for a small-scale pilot unit to be used in studying the reaction of anthracite with gaseous hydrogen at elevated temperatures and pressures. This small plant will permit testing at temperatures from about 900° to 1500° F and at pressures up to about 6000 psi.

At the University of Utah, the Department of Fuels Engineering is beginning a project designed to determine the product yields obtainable on mild hydrogenation of the distillates from high volatile bituminous coals. The effect of atmospheric oxidation on the ease of hydrogenation is being noted.

The Natural Resources Research Institute, University of Wyoming, has been doing research on the processing of low temperature "primary" tars. Hydrogenation of low temperature tars derived from coals ranging in rank from lignites to bituminous has shown that high quality synthetic crude oils can be produced from tars derived from any of them. By modifying operating conditions in a continuous tar hydrogenation unit, the quality of the product can be varied from an oil high in gasoline and organic chemical yields to a liquid containing large quantities of diesel fuels.

Fischer-Tropsch. U. S. Bureau of Mines work on the Fischer-Tropsch synthesis was continued and included the preparation and testing of different types of catalysts, the study of catalyst poisoning, pilot-plant studies on the hot-gas-recycle process and further attention to the preparation of synthesis gas without the use of pure oxygen. Bench-scale studies of the steam-iron process were also continued. Because of the inherent advantages of excellent temperature control and high productivity per weight of catalyst, the Bureau has continued its work on the use of catalyst in suspension in a liquid medium. Exploratory data were obtained on the influence of particle size, temperature, gas flow and catalyst concentration.

The problem of gas purification, fundamental to several of the Bureau's programs, receives attention.

Other Conversion Projects. A brief report was published by the University of Alabama, State Mine Experiment Station, on the relation of oxidation rates to nitric acid concentration for some bituminous coal, cokes and a lignite.

Production of liquids from coal was the object of a joint laboratory program of Consolidation Coal Co. and Standard Oil Co. of Ohio.

The Natural Resources Research Institute, University of Wyoming, has undertaken work on alkaline and acidic catalytic hydrolysis treatments of sub-bituminous coals and lignites.

Other Projects

Bituminous Coal Research, Inc., is studying the potential application of radioisotopes in the production, transportation, storage and use of coal. This project is fully sponsored by the Atomic Energy Commission. Also, BCR continued its research on utilizing fly ash from pulverized-coal-burning installations. Applications in the field showed cost reduction in mine shaft construction as a result of this work.

The Illinois State Geological Survey has made a study of the position of Illinois with respect to resources and conditions required for application of direct reduction processes to the production of iron.

At the University of Kentucky, a study of production costs, ownership structures, and employment changes in the coal industry is continuing in the College of Commerce. Also investigated was the feasibility of increasing facilities for the production of beehive coke in order to increase markets for coal. A new project is concerned with the feasibility of preparing lightweight aggregate from coal mine refuse.

The major research activity at North American Coal Corp. in 1959 was the erection and operation of a pilot plant to further investigate the recovery of high grade aluminum oxide and/or sulfate from coal mine waste in the Ohio Valley.

Work is continuing in the Department of Fuel Technology, Pennsylvania State University, on the use of anthracite as a filler material in amorphous carbon and graphite bodies and on the activation of anthracite by fluid bed technique to produce an active carbon.

The U. S. Army Corps of Engineers, Waterways Experiment Station, is carrying on a TVA-financed investigation of the suitability of TVA power plant fly ash for production of a portland-pozzolan cement.

Another TVA investigation is now under way to determine the feasibility of removing iron oxide particles from fly ash for use by the iron and steel industry as furnace feed material.

The Engineering Experiment Station of West Virginia University is carrying on a government sponsored study of the possible economic use of fly ash in highway construction.

Watch for "Part II—Coal Research in Canada and Abroad" in the March issue.

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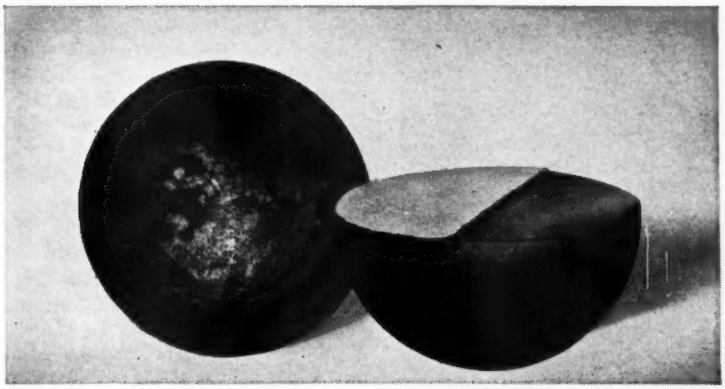

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The Gold Mining Industry in 1959

By DONALD H. McLAUGHLIN
President
Homestake Mining Co.

A spokesman for gold points out that our monetary procedures—allowing inflation to go unchecked—have already devalued the dollar to 40 cents in terms of 1940 buying power. So far, this devaluation has also "dragged down" the buying power of gold. But recent gold outflow to foreign creditors, and keener competition in international trade will eventually snap the tenuous tie between gold and the dollar. Then, the persistent value of gold, the author states, will certainly prevail.

THE welfare of the gold mining industry is so dependent upon monetary policies of the United States that any review of the performance and prospects of enterprises in this field must of necessity give principal attention to the current position of gold as money. Indeed, the increased interest on the part of the investing public in gold mining, which developed to a marked degree during the year, is to be attributed almost entirely to misgivings about the strength of the American dollar. The substantial outflow of gold from the country's monetary stocks and the failure to check domestic inflation led many to expect that a rise in the price of gold was likely in the reasonably near future.

These misgivings or hopes create new confidence in securities of gold mining companies, in spite of the fact that basically conditions continued to be most unfavorable for profits from sale of a fixed price metal in a period of inflation. Under these conditions, the output of gold would ordinarily be expected to decline, and in general this was the case except in South Africa where the production from the great new mines of the Orange Free State and from many marginal operations on the old Rand, whose lives were prolonged by profits from uranium, resulted in a new maximum total for the world as well as for this major gold field.

In the United States, the Homestake mine, thanks to increased rates of mining and milling, achieved a new record (572,014 oz valued at $20,020,486), but the total for the country will in all probability show a decline, due both to the virtual extinction of operations in most old districts and to strikes that shut down the prophyry copper mines for a time.

Increased interest in gold mining on the part of the investing public is to be attributed almost entirely to misgivings about the strength of the American dollar

As president of the nation's largest gold mining company, Donald H. McLaughlin is the natural spokesman for the domestic industry.

Dr. McLaughlin is renowned for his numerous major attainments in the fields of geology and engineering education, and is the author of many articles of importance to the mineral industries. With a career spanning 45 years, he is well known to the entire mining industry for his active and vigorous work in its behalf.

The apparent confidence in the stocks of strong gold mining companies under these conditions indicates that in certain sophisticated quarters, at least, it is expected that the American economy is headed for difficulties that before long will result in a revaluation of the dollar by conditions beyond our control.

Industrial Competition Abroad

Under our current monetary procedures, the nation is virtually off the gold standard at home, but on it abroad where dollars may be converted into gold at the prewar rate of $35 per oz through foreign Central Banks. This rather strange perversion of the gold standard removes the restraints that gold in the hands of the electorate could ordinarily place on inflationary practices on the domestic scene, and yet abroad preserves the illusion that the dollar is a "hard" currency.

This anomalous situation could be maintained without serious difficulty during the postwar years when the United States was practically the only major industrial nation with unimpaired productive capacity, when all the world needed all the goods it could turn out, and when the dollar shortage was the major problem in foreign exchange. In this period, world trade was supported primarily by the funds and resources made available as grants, gifts and loans by the United States. Now, however, with the European nations and Japan reestablished as major industrial nations, the situation has drastically changed. Intense competitive markets must be faced, and the handicap on the United States imposed by high costs measured in depreciating dollars is already becoming reflected in the changing ratio of imports and exports. The large balance-of-payment deficits have disappeared and indeed have been transferred to us, with the result that short

term dollar claims against us have reached new highs and gold has moved out of the country at a rate, which, if it continues for another year, is likely to create acute embarrassment.

With continued inflation at home and a dollar convertible into gold abroad, it is inevitable that the American competitive position in its foreign trade will deteriorate. Unless the depreciation of the dollar can be checked, which in the light of recent events seem most unlikely, this situation will certainly result in reduction of our gold reserves to a level where drastic action such as an embargo on further gold shipments or a devaluation of the dollar might be forced. As the commentator in the Morgan-Guaranty Survey of December 1959 put it, "in the new and more rugged current environment, we can no longer enjoy the luxurious paradox of a soft dollar at home and a hard dollar abroad."

The Immorality of Soft Money

Devaluation is an ugly word and has connotations that can well be regarded as immoral. But under the present pattern of monetary management, the devaluation of the dollar in purchasing power, which is its real measure of worth, has already been brought about to a degree that the 1940 dollar is now worth only about 40 cents. The devaluation of the dollar to this extent is indeed a fait accompli. What is now being attempted is actually the devaluation of gold itself by forcing it to conform to a fixed price measured in a depreciated and depreciating currency. The immorality of the procedure is the inflation that has already been accomplished which has effectively confiscated 60 percent of the savings of the people held in pensions, insurance and bonds.

So far, it must be admitted that the dollar has shown itself to be stronger than gold, as the money managers of a few years ago asserted it was. An ounce of gold in the principal capitals of the world will buy no more than can be obtained for 35 paper dollars. But this relation will last only as long as the outflow of gold from the United States can be tolerated. Eventually, and probably fairly soon if the flow of gold continues, the tenuous tie between the dollar and gold under these circumstances is certain to snap, and the international value of gold will assert itself by commanding a higher price in dollars.

A revaluation of the dollar in terms of gold—or a devaluation, if you will—would be most unfortunate, however, unless it were accompanied by the restoration of the gold standard with the dollar and hopefully other currencies redefined in terms of gold and made completely convertible at fixed rates that are realistic and that could be maintained.

Need Monetary Discipline to Check Domestic Inflation

It is most earnestly to be hoped that this essential step toward world monetary stability, which is prerequisite to stable international trade and prosperity, will be taken in time to avoid the evils that will inevitably result from continued inflation and to mitigate the depression that is all too likely to succeed the growing excesses of a false and deceiving prosperity based on depreciation of the currency.

Unless the American people are willing to accept the disciplinary procedures necessary to check domestic inflation—such as the elimination of wasteful expenditures and the avoidance of excessive wage increases, low interest rates, and recurring deficits met by monetization of debt—a revaluation of the dollar in terms of gold is inevitable if gold itself is not to be repudiated as the basic monetary commodity. If the conflict between gold and the dollar is forced by continued domestic inflation and by the attempt to maintain convertibility abroad at the old ratio, there is little doubt about the outcome. The persistent value of gold will certainly prevail.

Unless depreciation of the dollar can be checked, drastic action might be necessary to halt the reduction of our gold reserves

PHOSPHATE

World production increased nearly three percent while U. S. production was up about five percent and accounted for a larger share of the world total than in 1958

By O. E. POTHIER
Director of Mining Operations
J. R. Simplot Co.

O. E. Pothier graduated as a mining engineer from the University of Idaho in 1940. His early experience includes mining engineering in Idaho with Custer Consolidated Mines, Inc., and Callahan Zinc-Lead Co. World War II service with the U. S. Navy interrupted his career until 1946, when he returned to Callahan to make mine examinations and perform test work on mineral deposits. Pothier joined the Simplot organization in 1948 as a mining engineer in the development department, and since 1956 he has been director of mining operations, Minerals and Chemical Division.

THE phosphate rock industry continued its upward trend during 1959 with marketable production increasing in the United States by nearly five percent. Central Florida was the major producing area and accounted for over 71 percent of the total production. The western states, Idaho, Montana, Utah and Wyoming, followed with 16 percent and Tennessee with nearly 12 percent. Information and data from the Bureau of Mines and individual producers indicated that Florida and the western field increased output by five percent each, while Tennessee's production decreased two percent.

Florida's production is estimated at nearly 11½ million long tons. Tennessee's production declined to 1.8 million long tons. The western states produced 2.5 million long tons with Idaho accounting for over 1.6 million long tons.

In Florida the largest single producer is International Minerals and Chemical Co. Other mining companies operating there are: American Agricultural Chemical Co., American Cyanamid Co., Armour Co., Coronet Phosphate Co., Davison Chemical Co., Smith-Douglass Co. and Virginia-Carolina Chemical Co.

Agricultural Consumption Up

Approximately 20 percent of U. S. production was exported, 57 percent was prepared for agricultural purposes and 23 percent was used in the electric furnaces for manufacture of elemental phosphorous.

The uses of high analysis fertilizers have increased greatly in the past few years. This is primarily due to economies accrued in lower freight and handling costs. Agricultural phosphate materials are used as super-phosphates, triple superphosphates, nitraphosphates, ammonium phosphates, ammoniated phosphates, phosphoric acid and rock for direct application to the soil.

Superphosphates contain from 18 percent to 22 percent available P_2O_5 and are made by treating 32 percent P_2O_5 rock, or better, with sulphuric acid. Triple superphosphate contains 45 percent to 48 percent P_2O_5. A mixture of plus 32 percent P_2O_5 and

Over 68 percent of Western phosphate rock is used in the manufacture of elemental phosphorus

sulphuric acid is filtered, eliminating $CaSO_4$ and producing phosphoric acid of about 52 percent P_2O_5. The phosphoric acid is then used for acidulation of additional high grade rock to make triple superphosphate. There are various nitrogen fertilizers which are made by using ammonia, phosphoric acid, sulphuric acid and nitric acid. Phosphate fertilizer production for the first nine months in 1959 was up ten percent and shipments were up eight percent. Figures are not available for the last three months, however, indications are that this trend continued through the year.

Beneficiation of Eastern Phosphate Rock

The major part of eastern phosphate rock is beneficiated. The only Florida material used without concentration is soft or colloidal rock. In Tennessee, a small quantity of crude rock is blended with concentrated material for electric furnace feed. All other rock in Florida and Tennessee is beneficiated prior to marketing.

Beneficiation consists essentially of a washing operation. The matrix is generally 25 percent to 30 percent phosphate rock with the balance sand and clay. This material is slurried in the pits and pumped to the plant. The coarser sizes, down to 14 mesh, are recovered from the matrix by washing and by various screening methods. Minus 14 mesh, plus 35 mesh material is recovered by belt flotation and various gravity methods. The minus 35 to 150 mesh fraction is recovered in flotation cells.

Western Deposits Vary in Thickness and Grade

Production of mined rock in the western states increased 24 percent in 1959. This is accounted for partly by increased stocks, start-up of the Central Farmers Fertilizer Co. operation at Georgetown, Idaho, and an increase in production by J. R. Simplot Co.

Western rock is not uniform from one area to another. In Montana the ore consists of one bed about four to six ft thick of 32 percent P_2O_5. In Idaho the high grade bed is present, but there is also a bed of 24 percent P_2O_5, 15 to 30 ft thick. In addition, the phosphoria formation in Idaho contains a substantial tonnage of low grade rock. In southwestern Wyoming two high grade beds and the 24 percent shale member are present. In the eastern Uinta Mountains, in Utah, the high grade bed is not present. The ore in this area is a bed of 20 percent P_2O_5 rock, 20 ft thick. Western mining companies are: Central Farmers Fertilizer Co., J. R. Simplot Co., Monsanto Chemical Co., Montana Phosphate Co., San Francisco Chemical Co., and Victor Chemical Works Division, Stauffer Chemical Co.

Beneficiation of western rock has been increasing each year. This ore is more difficult to beneficiate than eastern rock and presents problems that eastern rock does not have. Certain areas in Idaho and Wyoming contain a high percentage of organics which are detrimental in making high-analysis fertilizers. A part and sometimes all of these ores are calcined, with a resulting beneficiating effect.

The western phosphate field has a substantial reserve of low grade ores of 12 percent to 20 percent P_2O_5. Considerable research is being done on beneficiating this material by sand-slime separation and flotation.

Elemental Phosphorus Produced Largely in Western U. S.

The present annual manufacture of elemental phosphorous is about 800,000,000 lb. About six percent of Florida's rock production, the major part of Tennessee's production and over 68 percent of the western rock is used for this purpose. Lower power rates in Tennessee and in the west account for the high percentage in these areas.

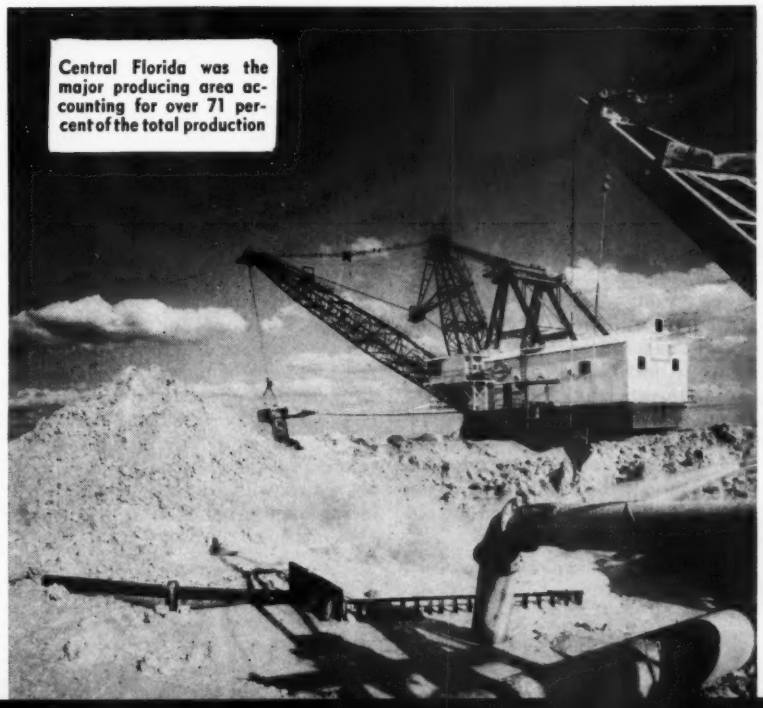
The first elemental phosphorous furnace was installed in the west in 1949. In 1959 production will be about 270,000,000 lb from four companies which are: Central Farmers Fertilizer Co., Food Machinery & Chemical Corp., Monsanto Chemical Co., and Victor Chemical Works Division, Stauffer Chemical Co.

Seventy-seven percent of the elemental phosphorous manufactured presently goes into industrial uses and exports, nearly 12 percent to fertilizer and over 11 percent goes to animal feed supplements. Industrial uses are many and are used largely as sodium, calcium and potassium phosphates and phosphoric acid. Over fifty percent is used in soaps, detergents and sanitizers; seven percent goes to foods and beverages, nearly five percent for water conditioning, and four percent for metal cleaning and surface protection. The balance is used in petroleum production, refining and additives, drugs, dentifrices, plastics, matches and fire retarders.

U. S. Accounted for 42 Percent of Marketable Rock

World production of marketable phosphate rock increased nearly three per cent in 1959 for an estimated total of over 35,000,000 long tons. The United States accounted for over 42 percent of the total. Foreign production was approximately 20,600,000 long tons.

Algerian production was about five percent below 1958 due to unsettled political conditions and the unknown future of the cartel. Tunisian production and shipments were down nine percent. During the year the Djebel M' Dilla phosphate mines were experimenting with a calcination beneficiation process. The nor-



Central Florida was the major producing area accounting for over 71 percent of the total production

mal grade of ore is 65 percent bone phosphate of lime (29.8 percent P_2O_5).

Production and shipments from Morocco were up 20 percent. Plans are presently under way for the construction of a triple superphosphate plant of 100,000 tons a year capacity. New high grade deposits containing 20,000,000 tons were found near the present operations.

The total combined output of Algeria, Tunisia and Morocco was 9,800,000 long tons. Egypt produced 490,000 long tons and South Africa had 250,000 long tons. Russian and European production is probably near 7,000,000 long tons and could be greater. South Pacific production was increased to over 2,700,000 long tons. The estimated Asian output was 720,000 long tons and South America and Mexico accounted for 330,000 long tons.

Plants are Being Reopened, Expanded and Modernized

There were a number of developments in the phosphate industry in 1959. Virginia-Carolina Chemical Co. at Nichols, Fla., reopened its Phosmico flotation plant in Feb. 1959. A new flotation plant now being built at Clear Springs will be in operation in May of this year. Virginia-Carolina Chemical is also expanding their triple superphosphate plant at Nichols. Hooker Chemical Co. is adding a third electric furnace to their plant and Monsanto Chemical Co. is modernizing their plant at Columbia, Tenn. Smith-Douglass, at Plant City, Fla., installed a new fluorine recovery unit which is reported to recover nearly all the fluorine emitted in their defluorinating process. Research is being carried out by nearly all the companies to improve beneficiation with emphasis on flotation.

In the west, a new operation, Central Farmers Fertilizer Co. at Georgetown, Idaho, started production in June, 1959. The operation consists of a 35,000 KVA electric furnace, rock beneficiation plant, fluosolids roasting and a triple superphosphate plant. Beneficiation includes washing, screening and desliming followed by calcination. The elemental phosphorous will be used for manufacture of fertilizer by converting to phosphoric acid. Three grades of ore are mined and transported one mile by conveyor from their open pit mine to stockpiles at the plant. Due to severe weather conditions, the open pit mine is not operated during the winter months.

Huge Utah Deposits Will Be Exploited

It was announced in October that Stauffer Chemical acquired Victor Chemical Co. Stauffer is a major stockholder in San Francisco Chemical Co., which is a major rock producer in southwest Wyoming and Utah. Stauffer is presently considering a 70,000 KW electric furnace in Utah. They have exercised their option on a 700,000,000 ton phosphate deposit in the Uinta Mountains, Daggett County, Utah. The ore averages about 20 percent P_2O_5 and will be beneficiated.

Bunker Hill company has started construction of a phosphoric acid plant at Kellogg, Idaho. The plant will cost about $2,000,000 and will produce 130 tons of phosphoric acid a day. This acid plant is the first unit of a proposed $12,000,000 ammonium phosphate and triple superphosphate plant. Ores will be obtained from their 1200 acre phosphate property located near Elliston, Mont., and sulphuric acid will come from their smelter operations at Kellogg.

J. R. Simplot Co. did not operate their Centennial mine in 1959. Equipment and personnel were moved from the Centennial mine to the Conda mine at Conda, Idaho, which was acquired from the Anaconda Co. in April of 1959. The ores are shipped to the Anaconda Co. and J. R. Simplot Co. Production facilities of J. R. Simplot Company's triple superphosphate plant at Pocatello, Idaho, were increased by 75 percent late in the year. Simplot also constructed a 400 ton sulphuric acid plant at Pocatello.

Monsanto constructed a 16 mile private road from their Ballard mine to the electric furnace plant for use of 100 ton trucks for ore haul.

Montana Phosphate Products Co., who is operating the Anderson mine near Garrison, Mont., purchased the mine, mill and phosphate mineral leases on approximately 1400 acres of federal land held by International Mineral and Chemical Co. near Hall, Mont.

There is expected to be an accelerated use of phosphate fertilizers over the next four or five years. In the west a great deal more phosphate fertilizers are being recommended by agricultural colleges and the Extension Service than are being used.

New industrial uses are being developed for the electric furnace product which will probably result in an increase in production of elemental phosphorous.

CEMENT

(*Continued from page 85*)

Airports

The arrival of the jet age in air travel has made necessary an enlarged program of civil airport construction. Awards for concrete pavement for civil airports, for example, increased 18 percent in the first three quarters of 1959. The Federal Aviation Authority has estimated that some $1.3 billion will be needed for airport improvements in the next three years, and that about 35 percent of this will go for pavement. Because concrete is the only pavement fully adequate for jet aircraft, this market for cement should continue to grow in the immediate future.

An outstanding project on which construction was begun in 1959 is the Dulles International Airport at Chantilly, Va., serving Washington, D.C. This completely new airport was designed for the jet age and all runways, taxiways and aprons are being paved with concrete.

Soil-Cement Paving

The rapid growth in use of soil-cement pavement for less heavily-travelled roads continued in 1959. Awards in the first three quarters were the equivalent of 3250 miles of 20-ft pavement. This is almost double the awards of a similar period two years earlier and 11 percent ahead of 1958.

The use of soil-cement for low cost paving is expected to continue expanding rapidly as supplies of high quality granular base materials become scarcer in many areas of the country. It appears that the potential of soil-cement, which has always been very great, is beginning to be realized.

A record year for shipments, continuing high construction activity and a vigorous program of development and promotion of new uses of concrete all contribute to a confident outlook for the industry.

The cement industry is not apt to set any great new records in 1960 but prospects for the coming decade appear to be most favorable. There is every indication that the total volume of construction will continue to expand even more rapidly in the next ten years than it has in the past ten. At the present time concrete, by volume, is used to a far greater extent than any other building material and there is good evidence that important new fields are being opened up to it.

STRATEGIC METALS

Domestic industry stifled by increased reliance on overseas sources

By C. HYDE LEWIS
President
New Idria Mining and Chemical Co.

PREVIOUS reviews of the strategic metal industry have, in recent years, emphatically indicated that the economic capacity for producing strategic minerals in domestic mines was dying. Today it is practically dead, so this review of the status of the industry in 1959 is necessarily short.

Antimony

A few years ago domestic mines supplied 40 percent of our requirements of antimony. Now we import 95 percent, and the remaining five percent is produced as a by-product of silver ores from Idaho, produced at no profit. A study of the sources of supply of antimony for American industry reveals that the combined production of the Western Hemisphere is no longer large enough to cover our needs. Mexican and Bolivian productions are down by 50 percent. Even our other source from within the free world, Africa, is down 50 percent, while Chile has increased its production by more than 100 percent. It is reasonable to wonder where our nation will obtain its antimony in the event of another emergency.

Chrome

The producers of high grade metallurgical chromite in Alaska, Washington, Oregon and California have ceased operations. One producer in Montana is in operation, filling out a contract with the Government, which is expected to run through 1960. Supplies for our domestic industry are now coming largely from Turkey and the east coast of South Africa, but producers there are complaining bitterly because of our importation of Russian chrome replacing their exports to the American market.

Cobalt

Up until 1959 this country was producing almost 50 percent of United States cobalt requirements. In the past year our only true cobalt mine, in Idaho, was shut down. During the clean-up, this operation recovered copper and let the cobalt run down the creek. We are now dependent upon supplies from Africa, where cobalt is produced as a by-product which can and will meet any market price.

An alternate source of supply is Fidel Castro's Cuba where our Government has guaranteed some large loans for developments which may or may not be able to produce cobalt in times of emergency.

Columbium

A single property in Idaho provided the bulk of our domestically produced columbium ore during 1959 under a Government contract for which all of the ore had been mined well before the end of the year. Since there is no indication that this contract will be extended, the columbium mining industry is, for all practical purposes, dead. Again our alternative source of supply is largely Africa.

Manganese

The so-called carlot domestic manganese purchase program of General Services Administration filled its quota and was terminated on August 5, 1959. Although there is still some metallurgical manganese ore being supplied to the Government on special contracts, the low price of imported ores, coming largely from Brazil and India, precludes any possibility of maintaining a healthy domestic manganese mining industry.

C. Hyde Lewis graduated as a mining engineer from the University of California in 1927 and has long been associated with the strategic metals industry. After five years with Phelps Dodge Corp. in Arizona, in 1928 he joined H. W. Gould & Co., a San Francisco management and engineering company. From 1932 to 1936 he was a consulting engineer, and in 1936 he was employed by Getchell Mining Co. in Nevada. Lewis joined New Idria Mining & Chemical Co. in 1937 and is now president and a director.

Mercury

According to the U. S. Tariff Commission, domestic mercury production during 1957 and the first half of 1958 was carried on at an overall loss, and even that loss did not include several million dollars worth of unsuccessful exploration and development which was omitted from the tariff commission report. The Government's mercury purchase program was terminated at the end of 1958. The bulk of the mercury purchased under the program was utilized by Government Agencies.

Mercury production in 1959 is estimated to have been 20 percent below that of 1958. The fact that it remains even that high is in spite of, and not because of any systematic planning. Our Government has patronized foreign producers extensively in the procurement of stockpile and AEC requirements, obtaining them from Mexico, Italy and Spain where labor costs range from 5 percent to 25 percent of American labor costs.

Tungsten

At least one and possibly two mines in the United States are producing tungsten concentrates as a by-product from mining operations producing complex ores which contain other marketable minerals, but certainly, our domestic production will not satisfy more than ten percent of our peacetime requirements or about 2½ percent of the demands experienced during the Korean conflict. Despite the fact that our defense needs are running into increasingly high temperature requirements, Western Hemisphere production of tungsten ore is declining toward the vanishing point. In the event of another military emergency, whether it is a major or minor action, the mining industry will be hard put to satisfy the need for carbide-cored anti-tank projectiles or the tungsten required in high temperature alloy steels for military use—which will again emphasize the old saying regarding the horseshoe nail and the loss of a military campaign.

Reliance on Undependable Supplies

Over the past few years the strategic metal industry as a whole has had

(*Continued on page 116*)

URANIUM

By A. M. MASTROVICH
Vice President and General Manager
Climax Uranium Co.

Uranium Reduction Co. mill at Moab, Utah

1959 was a year of transition for the domestic uranium industry. Exploration was drastically reduced. The November 24, 1958 announcement issued by the U. S. Atomic Energy Commission materially revised the prospectus for uranium markets in the 1962 to 1966 period

INDUSTRY and the U. S. Atomic Energy Commission alike were busy throughout the year in a reappraisal of ore reserves, market programs and policies. The groundwork was laid for the definition of policy required in the renegotiation and extension of milling contracts which presently expire prior to the end of 1966. In 1959 some contracts were extended or increased in accordance with such concepts.

This adjustment continued to materialize in an atmosphere of increased restriction for the domestic industry. But some positive developments began to appear which gave cause for increased but cautious optimism for the long-range outlook for the industry.

Consumptive uses for uranium increased somewhat through such programs as the Nation's domestic nuclear power program for private industry, the Navy's and Maritime nuclear propulsion programs and the rapidly increasing production of radioisotopes for agriculture, industry and medicine. Vanadium markets experienced marked improvement during 1959 which brought some encouragement to production of that uranium ore which is associated with vanadium.

A. M. Mastrovich's 12-year association with the uranium industry on the Colorado Plateau coincides with its tremendous growth from infancy. We proudly present his review of uranium, which covers the most significant factors related to this growth.

Mastrovich, a 1932 mining engineer (geologic option) graduate of South Dakota School of Mines and Technology, has a varied background that includes 20 years in mining and geologic positions with Homestake Mining Co., Union Mines Development Corp., U. S. Vanadium Corp. and American Smelting & Refining Co. He joined Climax Uranium Co., a division of American Metal-Climax, in 1952 as assistant mine manager. In 1957 he was promoted to vice president and general manager.

The Commission negotiated some important stretch-outs in its foreign uranium procurement program which will result in reduced annual fiscal commitments in the years immediately ahead. This action will relieve some of the pressure building to further curtail the procurement program.

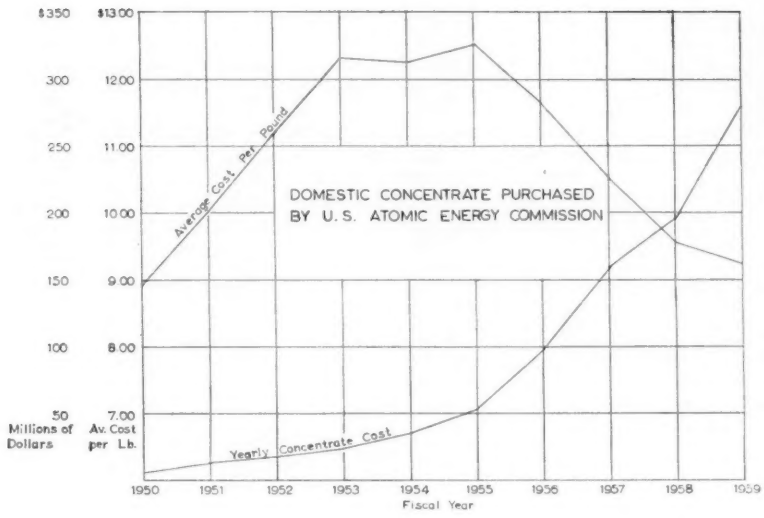
Domestic Uranium Procurement Program—Background

The program for the purchase of uranium by the U. S. Atomic Energy Commission was based upon a series of circulars which provided a schedule of prices for ore allowances, and bonuses. These served as an incentive to many prospectors in searching and finding uranium. Circular 5, revised, served as the principle foundation for the buying program supplemented by a pattern of mill contracts, each individually negotiated with individually established prices for concentrate.

On May 24, 1956, the Commission extended its procurement program from the terminal date of Circular 5, March 31, 1962, to the end of the calendar year, 1966. The announcement stated that "the new domestic procurement program provides a guaranteed market for all uranium concentrates produced by domestic mills from domestic ores, subject to a limitation, at the Commission's option, of 500 tons of U_3O_8 per year from any one mining property or mining operation, and to a compliance with Commission's specifications."

The announcement established a price of $8.00 per pound of U_3O_8 contained in the mill concentrate for the post '62 period. No provision was made for the continuation of haulage allowance or other incentives beyond their present terminal dates.

On October 28, 1957, the Commission informally established a policy of limiting uranium production "to the approximate level which will be reached as the result of existing commitments." This limitation on the domestic industry resulted in protests from certain districts under early



stages of exploration and development. As a result, the Commission reappraised its position and issued a report on April 2, 1958, permitting "limited expansion" of milling facilities in areas which were found to be suffering from a market hardship because of inadequate milling capacity.

Administrative policy of the Commission thereafter tended to limit market obligations of the Commission in the pre-'62 period to those ore reserves developed prior to November 1, 1957. It must be remembered that this announcement had no effect upon the market after March 31, 1962.

On November 24, 1958, the Commission announced that it would sustain the market guarantee contained in its May 24, 1956 announcement, only for those ore reserves already developed. On the basis of the aggregate of commitments made by the Commission in mill contracts and official announcements, the uranium procurement program after March 31, 1962 was thereby limited to: (a) current milling contracts; (b) appropriate extensions of current milling contracts to the extent the Commission determines that the milling facilities are needed for the presently existing mining operations and developed ore reserves; (c) new milling contracts or amendments to existing contracts which may be executed pursuant to the Commission's April 2, 1958 announcement of the limited expansion of the domestic uranium procurement program; (d) new milling contracts or contract amendments which may be negotiated for the purchase of appropriate quantities of concentrates in the 1962–66 period from ore reserves developed between November 1, 1957 and November 24, 1958.

The Commission justified its revised program by stating: "The effect of this modification will be to provide the domestic uranium industry with a substantial continuing market during the 1962–66 period for concentrates derived from already developed ore reserves and, at the same time, guard against overproduction."

With respect to new ore reserves developed after November 24, 1958, the Commission stated that it would make contracts to purchase concentrate to the extent that requirements dictate and on such terms and conditions and at such prices as the Commission may from time to time agree upon.

The AEC will give protection to the independent miners by incorporating in all new milling contracts, provisions designed to provide independent mine owners a fair share of available milling capacities.

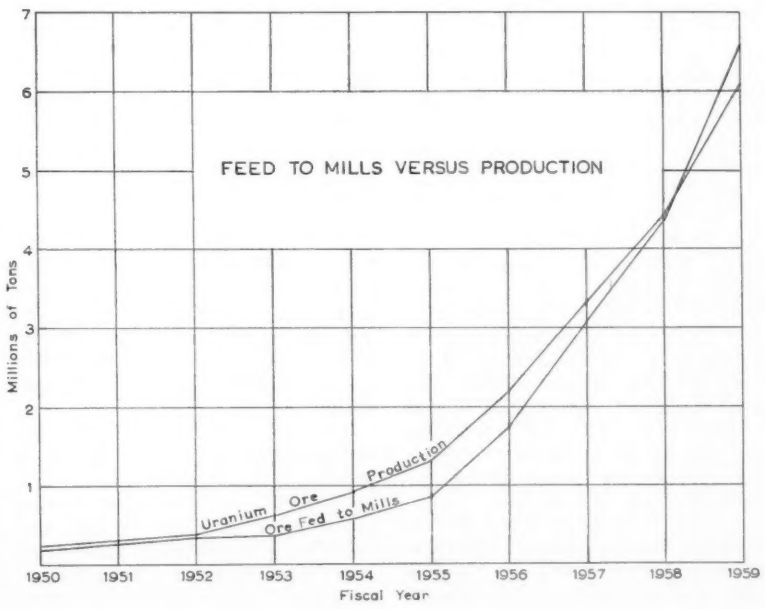
Administration of November 24, 1958 Announcement

In order to administer the post-'62 program, the Commission has created a mining allocation system based upon ore reserve and production data. As the first step in establishing such a system of allocation, the Commission's Grand Junction operations office has requested operators of uranium properties to submit data on their reserves, past production, description of properties and complete coverage of costs. The final establishment of mining allocation quotas based upon production and ore reserve data will, in effect, result from negotiation between the Commission and the individual operator.

The flat price set for uranium concentrate by the November 24, 1958 announcement makes it imperative that the miller and shipper successfully negotiate a price for ore which will include haulage.

Even if the mining allocation embodied in the proposed program works on the most favorable basis, there will undoubtedly be operations which will not prove economic, and therefore, the allocations from such operations will not be fulfilled.

As the Commission program is now conceived to work, the unfulfilled allocations will revert to the Commis-



sion. The miller to which the allocations were assigned consequently will lose an equivalent amount of mill feed. As presently indicated, exceptions will probably be made only if the need arises for increased production of yellow cake.

Over a large segment of the domestic uranium industry, the establishment of an $8 price for U_3O_8 concentrate has not as yet been demonstrated to be practical and economical. For many operations in the post 1962 period, compliance with the November 24, 1958 notice will mean the mining of only the better grade zones with no consideration given to blending with lower grade ores. The net effect over the years may well mean a partial loss of our domestic uranium reserves.

Drilling, Reserves, Production and Milling

During the early years of the uranium program, the Government, through the U. S. Atomic Energy Commission and the U. S. Geological Survey, did a great amount of drilling in the search for ore deposits. As private industry gradually took over this phase of exploration the Government withdrew. Figures released by the Commission show that in 1948, government drilling totaled 130,000 ft vs. 80,000 ft drilled by industry; in 1955, government drilling was 529,000 ft vs. industry drilling of 5,500,000 ft; in 1956 it was 40,000 ft vs. 8,750,000 ft; in 1957 and 1958, the government did no drilling while industry drilled 16,500,000 ft. During 1959, the government continued its policy of no drilling; and industry, for the first time since 1948, drastically curtailed its exploratory drilling, due principally to the adverse effects of the Nov. 24, 1958 announcement, which, in effect, nullified government markets for uranium from new discoveries.

Commission figures reveal that, due to the extensive drilling program mentioned above, domestic ore reserves were increased from an estimated 1,000,000 tons in January, 1948 to 88,900,000 tons by July, 1959. Ore reserve estimates were determined by the Commission in accordance with definitions for measured, indicated and inferred ore as adapted by the U. S. Geological Survey and the U. S. Bureau of Mines, and include only material metallurgically amenable to treatment.

During fiscal year, 1958, ore fed to mills was in balance with production. In fiscal 1959, for the first time, the ore fed to mills exceeded production by some 500,000 tons, the difference being derived from reduction of government stockpiles. It is expected that the domestic industry through Dec. 31, 1966 will maintain a reasonable balance between ore produced and ore fed to process and that little if any ore will be purchased by the Commission for future stockpiling.

TABLE I URANIUM PROCESSING PLANTS

State	% of Total Milling Capacity	Company and Location	Rated Capacity-Tons Per Day	Est. Cost of Mill	Present Contract Terminates
Arizona	1.3	Rare Metals Corp. of America, Tuba City	300	$ 3,600,000	3/31/62
Colorado	16.7	Union Carbide Nuclear, Rifle	1000	8,500,000	3/31/62
		Vanadium Corp. of America, Durango	750	813,000	3/31/62
		Union Carbide Nuclear Corp., Uravan	1000	5,000,000	3/31/62
		Climax Uranium Co., Grand Junction	330	3,088,000	7/31/60
		Trace Elements Co., Maybell	300	2,208,000	3/31/62
		Gunnison Mining Co., Gunnison	200	2,025,000	3/31/62
		Cotter Corp., Canon City	200	2,000,000	2/28/65
New Mexico	49.0	Anaconda Co., Bluewater	3500	19,358,000	12/31/66
		Kerr McGee Oil Industries, Shiprock	300	3,161,000	6/30/65
		Homestake-New Mexico Partners, Grants	750	5,325,000	3/31/62
		Kermac Nuclear Fuels Corp., Grants	3300	16,000,000	12/31/66
		Phillips Petroleum Co., Grants	1725	9,500,000	12/31/66
		Homestake-Sapin Partners, Grants	1500	9,000,000	6/30/63
Oregon	0.9	Lakeview Mining Co., Lakeview	210	2,600,000	11/30/63
So. Dakota	1.8	Mines Development Inc., Edgemont	400	1,900,000	3/31/62
Utah	13.7	Vitro Uranium Co., Salt Lake City	600	5,500,000	3/31/62
		Uranium Reduction Co., Moab	1500	11,172,000	12/31/66
		Texas-Zinc Minerals, Mexican Hat	1000	7,000,000	12/31/66
Washington	1.8	Dawn Mining Co., Ford	400	3,100,000	3/31/62
Wyoming	14.8	Western Nuclear Corp., Jeffrey City	845	4,300,000	12/31/66
		Lucky Mc Uranium Corp., Fremont Co.	980	6,900,000	12/31/66
		Susquehanna-Western Inc., Riverton	500	3,500,000	10/31/63
		Federal Radorock-Gas Hills Partners, Fremont County	522	3,370,000	12/31/66
		Globe Mining Co., Natrona County	492	3,100,000	12/31/66
	100.0		22,604	$142,020,000	

The 25 domestic mills in operation today (Table I) have a combined rated daily capacity of 22,604 tons and cost over $142 million. The Government-owned mill at Monticello, Utah was put on a stand-by basis at the close of 1959.

In the fiscal years 1948 through 1959, the Commission incurred costs of $888 million in connection with the procurement of uranium concentrate (U_3O_8) from domestic sources. These costs include the purchases from private producers, the operations of the Commission mill at Monticello, Utah, and the weighing, sampling and assaying of ores, but exclude depreciation on Commission facilities, bonus payments for initial ore production and vanadium purchases.

From the beginning of the Atomic Energy program to July 1, 1955, 83 percent of the uranium purchased by the United States came from foreign sources. Between July 1, 1955 and June 30, 1962, 47 percent of the Commission's uranium purchases will be from domestic sources and 53 percent from foreign. Of the outstanding contracts and commitments for the period June 30, 1962 through Dec. 31, 1966, 84 percent of the uranium which the Commission now is committed to buy will come from domestic sources.

Consistent with the expressed purpose of the Nov. 24, 1958 announcement of guarding against overproduction, the Commission announced on Nov. 6, 1959 that it would not be in a position to exercise its options to purchase additional Canadian uranium concentrate in the post-1962 period. Existing contracts with the Canadian Government for the purchase of Canadian produced uranium were revised to permit a "stretchout arrangement . . . during the period of March 31, 1962 through Dec. 31, 1966." In making the announcement, AEC Chairman John A. McCone noted that Canada's action in developing its uranium industry was a "major contribution to the defense of the free world."

Mining Operations

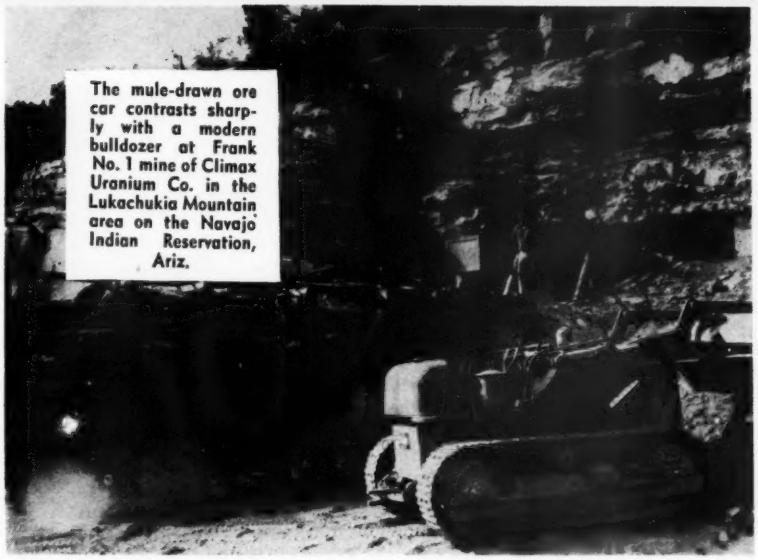
During the past year the industry continued to make advances in improving mining methods, particularly in those districts where the larger operations are established. Mining methods vary widely from district to district and are directly dependent on the size, shape, character, accessibility and grade of ore bodies. The

methods used in some of our better known districts are briefly summarized in the following paragraphs.

Operations on the Colorado Plateau, our oldest district, are confined to the mining of flat and tabular ore bodies that abruptly pinch and swell. Most mines, large or small, are opened by horizontal adits, or inclined or vertical shafts as determined by physical and economic conditions. Approximately 60 percent of the mines produce from 50 to 500 tons of ore per month and employ two to six men. In these smaller operations, mining is largely a "gopher-hole" proposition and ore streaks down to six in. thick are selectively worked, with excavations sufficient only to allow room to work. Hand mucking and tramming are common and a mule may be used on the longer trams. The larger operations, usually designed to mine ore bodies of one to several hundred thousand tons, are well laid out programs with emphasis on engineering and geology; mining practice in these mines often combines stoping with waste areas left as pillars and slushing to tracked haulage drifts located below the ore body. In mines with thick overburden, Calyx holes are used for escapeways and ventilation, and extensive long hole drilling is being done to facilitate the search for ore.

In the Ambrosia Lake area of New Mexico mining below the water table presents some difficult problems. Haulage drifts are extended below the ore with vertical upholes drilled during the advance to speed drainage. Ore up to ten ft thick is being mined by modification of the room and pillar method or by the panel retreat method of controlled caving; the mining of thicker ore, from 10 to 90 ft thick, is still a problem and the use of the cut and fill method is a likely possibility. Experience to date has shown that the sandstone host rock is not homogeneous, permeability is not the same in all directions, and the strength of the rock increases proportionately with loss of moisture. Much has been learned about handling sloppy muck, clarifying mine water and roof bolting in soft backs. Trackless haulage has been favored by several companies but wet haulage ways plus the highly abrasive character of the ore has caused some of the operations to shift to conventional haulage methods.

In the Gas Hills and Crooks Gap districts of central Wyoming near-surface ore bodies occurring in poorly consolidated facies of the Wind River formation of Eocene age are mined cheaply by open pit operations. Where permissible, stripping of overburden above the ore is removed in one continuous operation by large capacity scraper-tractors in combination with "push cats." Locally, premine stripping must be carried on in several phases where multiple ore horizons occur. Following the stripping operation, closely spaced wagon drilling for ore grade control is necessary to effectively mine the undulating ore bodies. Dust samples are collected and scanned with a beta-gamma scaler and assay data are plotted on mining control maps. Actual mining is done with small shovels or front-end loaders in combination with medium-size dump trucks. Each load is probed prior to dumping on selective stockpiles based on grade.



The mule-drawn ore car contrasts sharply with a modern bulldozer at Frank No. 1 mine of Climax Uranium Co. in the Lukachukia Mountain area on the Navajo Indian Reservation, Ariz.

In the Big Indian district near Moab, Utah, one operator employs long wall stoping with caving to mine a relatively thin and hard but high grade ore body with a soft and incompetent back. Complete extraction with minimum dilution is attained by use of two rows of extensible steel props for temporary support while a long wall slice is mined. After slushing along the wall the row of props farthest from the face is recovered and reset near the face. As mining advances, the mudstone roof caves under control after the removal of each successive row of props. Minimum pressure on the roof is maintained along the long wall face.

Ore Processing

In the July, 1959 issue of Mining Congress Journal, William L. Lennemann and Frank E. McGinley described in considerable detail "Advances in Uranium Ore Processing."

One of their closing remarks was: "In all probability, the future significant developments in uranium ore processing will not be so much in new process technology as in operating techniques and equipment design to perform operational functions more suitably and more cheaply."

Developments during 1959, have followed this trend very closely. Several significant developments are worthy of mention.

Kermac Nuclear Fuels Corp., Grants, N. Mex. mill was on stream by early Dec. 1958. During 1959, this mill continued to demonstrate the anticipated efficiency and economy which resulted from detailed pilot work, mill design and employee training. The circuit utilizes acid leaching, counter-current decantation and solvent extraction.

Susquehanna-Western, Inc. (formerly Fremont Minerals, Inc.), Riverton, Wyo. mill which started late in 1958 utilizes parallel acid and carbonate circuits. Also included is a solvent extraction circuit. This circuit provides for considerable flexibility of operation in the treatment of several "difficult" types of ores.

Uranium Reduction Co., Moab, Utah mill completed the conversion of approximately half of its capacity to an alkaline leach, R-I-P circuit. The purpose of the conversion was to treat ores which contain more than 10 percent lime at a cost lower than that for the acid leach process.

Federal-Radorock-Gas Hills Partners, Fremont County, Wyo. mill was on stream by Nov., 1959. This mill has an acid leach circuit which utilizes counter current continuous ion exchange.

Kerr-McGee Industries, Shiprock, N. M. mill was shut down at the termination of a contract which expired Oct. 31, 1959. A contract extension to mid-1965 was successfully negoti-

ated and a three or four month program of construction was in progress at the end of the year to provide additional equipment for the recovery of V_2O_5 which had formerly been impounded in the tailings. A solvent extraction circuit for the recovery of V_2O_5 will follow the present SX circuit for U_3O_8. Union Carbide Nuclear Co., Rifle, Colo. mill also utilizes solvent extraction for V_2O_5 recovery.

The Commission was emphatic in its insistence that all U_3O_8 concentrate delivered, comply with specifications covering maximum limits for impurities. It is expected that this demand will be continued with reasonable allowances for time for new mills or those with major problems to meet the specifications. Vanadium and molybdenum were two of the impurities which were of particular concern.

Future developments in uranium ore processing should be interesting to observe in the next three to six years. With a fixed price of approximately $8.00 per pound for U_3O_8, any increase in labor, reagent, material or other costs, or any decrease in the quality of ore received, will increase the necessity for all operating companies to find new means of reducing unit costs in milling operations.

Radiation Developments

During 1959, the uranium industry took increasing measures to guard against radiation hazards from three general sources:

(1) Excessive concentrations of radon and its daughter products in the air of uranium mines,
(2) Control of excessive quantities of airborne uranium dust in milling operations, and,
(3) Regulation of the level of radium and other contaminants in the discharge of liquid effluents from uranium mills to river or portable water systems.

Many operators found it desirable to establish working relationships with the state health agencies, the U. S. Bureau of Mines, the Atomic Energy Commission, and the U. S. Public Health Service in order to assure that they were adquately informed with regard to all regulations effecting their operations.

In uranium mining the problem of radon daughter concentration in the mine atmosphere received increasing interest. Simple field methods are available for measuring radon daughters and for estimating ventilation requirements. Dilution ventilation is the only control method which has been applied to date for controlling radon daughter concentration and the cost of providing adequate volumes of air can be a significant factor in the economics of the operation of a mine.

In the past year, the Commission intensified its efforts to enforce compliance with its standards for protection from radiation. (Title 10, Part 20 of the Federal Register, Jan. 27, 1957.) The Commission publicly cited 11 mill operators for failure to comply with these standards. Apparently most of these citations were made because of the slow start made by these mill operators in establishing a radiation survey program. Also, the U. S. Public Health Service showed interest in radioactive mill effluents as possible sources of stream contamination and action was taken against one uranium mill operator for allegedly polluting an inter-state river.

In the majority of the mills, the external gamma and beta radiation levels are too low to be of concern as possible sources of radiation injury. The principal problem is that of control of the concentration of airborne uranium dust. Sampling of airborne uranium and the determination of the uranium concentration in air is a relatively simple matter and easily within the capabilities of the laboratory facilities of the uranium mills. Control of the concentration of airborne uranium can be achieved by careful housekeeping and the use of conventional dust collection equipment in those operations which generate airborne dust.

Compliance with those provisions of the standards which regulate the quantities of radium that may be discharged in the liquid effluents from uranium mills is most difficult. The analysis of radium in mill effluents, at the acceptable levels, requires a procedure which is expensive and which may be subject to appreciable errors. Additional research on the analytical methods is needed before the mills can accurately estimate the quantity of radium being discharged in their effluents. Corrective measures are now in their early stages of development, and suggest costly and involved procedures in their application.

The currently enforced Standards for Protection Against Radiation (Part 20) are based on recommendations made by the National Committee on Radiation Protection published in Handbook 52 of the National Bureau of Standards dated March 20, 1953. On June 5, 1959 the National Bureau of Standards issued Handbook 69 which supersedes Handbook 52 and contains values which reflect the current thinking of the NCRP. The Commission has not revised its Part 20 standards to conform with Handbook 69.

During 1959, the Federal Radiation Council was created. This new agency is directed by officials of affected federal agencies, and is expected to coordinate the work of these agencies. In addition, the Council will aid in preparing states to take over a part of the burden in regulating and controlling radiation hazards.

It is interesting to note that in hearings held to consider legislation establishing the Council, Dr. Lauritson Taylor, Chief of the Atomic Radiation Physics Division of the National Bureau of Standards, stated that the present standards recommended by NCRP are based on the absence of observable effects on the human body. This, he added, is a "negative approach" to the problem, but he submitted that there is "no other way to do it."

Dr. Russell H. Morgan, Chairman of the Advisory Committee on Radiation of the U. S. Public Health Service, stated that the maximum permissible concentration levels, as provided in present radiation standards, are meaningless and "based on something other than scientific facts."

The public citations experienced by the industry during 1959 are symptomatic of the urgency felt by the appropriate authorities to establish and maintain rigid control on radiation hazards in the industry. The adverse publicity caused by those citations was unfortunate, and perhaps unwarranted in view of the primitive state of our knowledge of this hazard. The years immediately ahead should see a closer coordination of all private and public groups to effect the required corrections and to reestablish a more positive impression in the eyes of the public.

Outlook for Uranium

The first concern of the uranium industry with regard to the immediate future is the renegotiation of mill contracts which do not yet extend through the 1962–66 period. Apparently Commission policy now indicates that contracts will be extended in those cases where sufficient reserves have been proven as of Nov. 24, 1958, and those that will justify operating economics required under $8.00 price per pound of uranium concentrate.

Developments have occurred during the last year that have somewhat strengthened the outlook for uranium

markets beyond the Government support program. A few of the country's major nuclear equipment manufacturers now assure us that large nuclear power plants can be built that will produce electricity at seven to eight mills per kilowatt hour.

This compares favorably with the national average of power generating costs. It means that we can now anticipate that nuclear power plants can be built in high cost fuel areas such as the West Coast, New England and the Southeastern United States which can economically compete with power produced from conventional fuels. Further improvements will have to be made in nuclear power production. however, before atomic plants can be competitive in the low-cost fuel areas of this country.

The full period of the remaining Government guarantee market for uranium will be required to adequately prove the economic feasibility of nuclear power in this country.

Allowing for this experience factor and the growth of power demand in this country, it is conceivable that by 1975, about 10 percent of this nation's estimated two billion megawatt hours of electric generation can come from uranium. This represent a consumption of some 4,200 tons of natural uranium. By 1980 there is reasonable assurance that the uranium requirements for electric power coupled with process heat and space propulsion from nuclear sources will equal the present levels of domestic production or about 18,000 tons of natural uranium per year. Inventory requirements, advance production scheduling, and the possibility of unforeseen technical developments further enhance this picture.

While this long range prospect suggests a very heartening future for the uranium industry, the period between 1967 and 1975 remains in doubt at the present time.

Perhaps the greatest factors that will influence the demand picture for uranium will be the advancement in power conversion efficiency of uranium and the development of foreign markets. There now appears a possibility of efficiency improvement through spent fuel reprocessing by a factor of four times by 1980, and ultimately as great as 30–50 times as breeding reactors become efficient. Favorable developments in this area could render atomic power extremely economic and make this new energy source of widespread appeal throughout the world. Under such conditions, the future of the uranium industry would be indeed bright.

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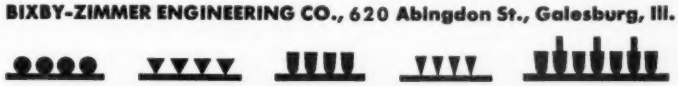

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COPPER

Production and consumption; its past and its future

By JEAN VUILLEQUEZ
Vice President
American Metal Climax, Inc.

IN choosing our period of the past production and consumption of copper, we think the recent period, 1947 to 1958, is more amenable to approximate comparison with the next decade even though it includes reconstruction in the war ravaged countries. These countries, therefore, show a much greater rate of growth than the United States which was spared war destruction.

Over the period 1947 to 1958 mine production of copper in the world, exclusive of iron curtain countries, increased from about 2,250,000 tons in 1947 to 3,250,000 tons in 1958. This is an increase of about 44 percent during a period which began about a year after the end of the most destructive war in history and ended in a year of recession in the United States.

Available statistics of consumption of copper represents deliveries of refined copper to fabricators. This consumption increased by about 45 percent. The rate of growth of consumption varies country by country. While consumption in the United States showed very little change—in fact a moderate decline due to the 1958 recession—the growth outside of the United States was about 117 percent.

Since the end of World War II there have been a number of periods during which copper was in short supply. This shortage was due partly to purchases for national stockpiles, especially in the United States, partly to periods when price ceilings reduced production and imports, and partly to reductions in production chiefly due to labor problems. All of these factors reduced supplies to consumers and some of them eventually increased prices excessively. Consumers were discouraged and tried to find substitute materials.

Jean Vuillequez, a native of New York, was educated in its public schools and at New York University. Since joining American Metal Co. (now American Metal Climax, Inc.) in 1927, he has performed almost every commercial position in the company. Vuillequez entered the sales department in 1935 and was made assistant manager of sales in 1943. He became manager of sales six years later and director of sales the following year. In 1953 he rose to vice president in charge of sales and since 1956 he has been a director and member of the executive committee.

The substitutions for copper which resulted from conservation measures adopted during World War II and Korea are difficult to regain. In the United States the products of brass mills, copper alloys and straight copper products, suffered badly. However, the use of copper for electrical purposes increased about as fast as industrial production as reported by the Federal Reserve index.

Like many other companies in the industry, American Metal Climax, Inc. tries to estimate the future growth of copper consumption. We do this with the full knowledge that such projections are subject to substantial error. We use the figures as a guide rather than as an exact tool for business decisions. Even then we use them with trepidation and great care. Nevertheless we find them useful even if partly conjectural. Our present projections indicate that by 1970 the annual consumption of refined copper in the world, exclusive of the iron curtain, may well increase by about 2,000,000 tons, or by more than 50 percent of the present consumption.

Consumption Growth Predicted

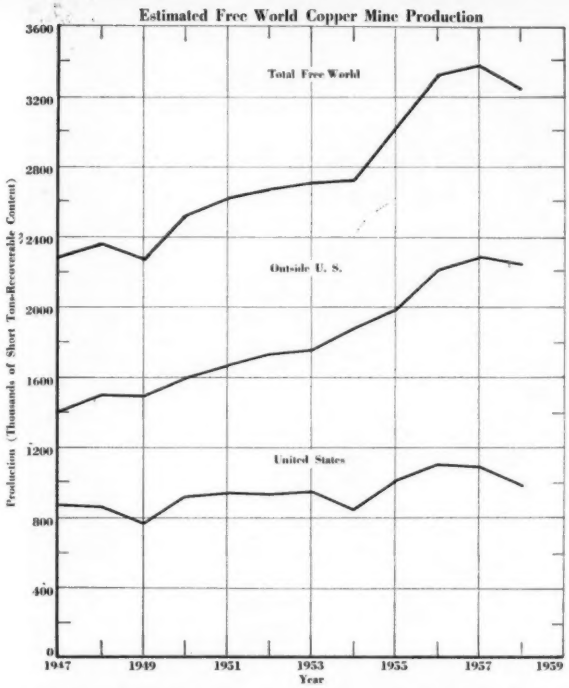
While consumption of copper in the United States has not shown significant overall growth in the last decade, it would be a mistake, in my opinion, to assume that the same thing will happen in the next ten to eleven years. We see no reason to question the continued substantial growth of copper in the United States for electrical purposes and see a number of reasons why the past reduction in use of brass mill products has been arrested and indeed should change to reasonable growth.

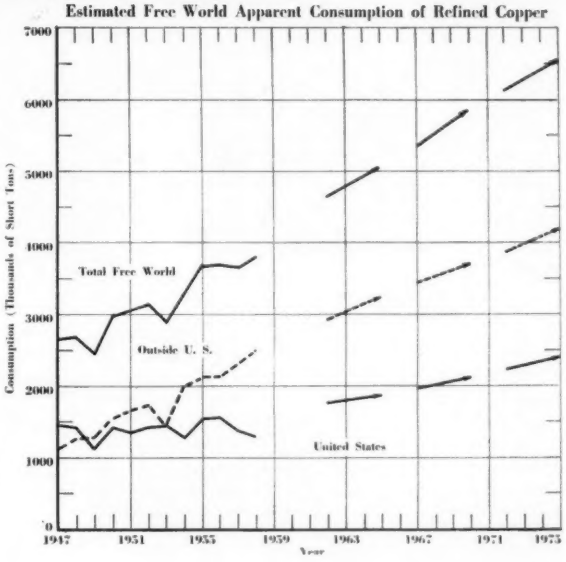
Of this increase of about 50 percent, we think that the growth in the United States may be about 30 percent, thus most of the increase will be outside of the United States chiefly in the principal industrial countries such as Belgium, Canada, France, Italy, Japan, the United Kingdom and West Germany. We consider our estimates conservative. We cannot foretell the much greater rate of growth which I believe is bound to occur in underdeveloped countries. We do not include Iron Curtain countries whose future consumption needs we cannot estimate but which will probably also increase substantially. Whether these increased needs will be met by their own production or by imports from the West can only be surmised. It should be noted, however, that in recent years the Iron Curtain has purchased copper from the West, and at present is interested in purchasing additional quantities.

An estimated overall growth of 50 percent in about eleven years is certainly not spectacular. Copper is needed in most new products and technological developments; but it is not a new metal, it was used before the Bible, and our estimate of its growth does represent a good steady rate of about 3¾ percent per annum compounded annually.

New Mines Needed During Next Decade

If our projections of consumption increases are reasonably accurate, production capacity will have to increase substantially. According to our production forecasts, the annual mine production capacity by 1963, here and abroad, will increase by about 600,000 tons. This is after deducting the output of mines whose ore reserves are expected to become exhausted. This figure includes the Ray, Esperenza, Christmas mines and Asarco's East Pima property. It includes increases in Canada, the El Salvador, Mantos Blancas and Rio Blanco mines in Chile; Toquepala in Peru; Mufulira, Bancroft and Katanga increases in Africa and finally increases in Europe, Asia and Mt. Isa in Australia. This increase in production capacity of 600,000 tons by 1963 appears to be keeping good pace with our projections of an increase in consumption of 2,000,000 tons by 1970. A part of the additional 1,400,000 tons needed by 1970 will come from an increase in the supply of scrap, and from increases in the capacity of present and planned mining operations. But a good part will have to come from new discoveries or from old discoveries which for one reason or another, are not





planned for production at this time.

The writer is confident that this additional copper will be found and produced, although no one knows what price will be required to encourage its production. It will probably have to be higher than 30 cents per pound unless, of course, a huge new very low cost copper area is discovered. The location of new mines, type of orebody and grade of ore will, of course, play an important part in the capital cost of new discoveries. According to our estimates the capital investments for recent expansion programs has varied from about $500 to about $2,000 per ton of annual capacity. The capital cost for new copper mines or projects has ranged from about $750 to about $2,500 per ton of annual capacity. In some cases the costs are through the milling stage only. In others a smelter is included, and some provide for a smelter and refinery. But even through the same stage of beneficiation the capital costs vary widely. These costs are not on the way down and the price of copper will have to reflect them, and the other costs of producing, financing and distributing copper, plus a profit on the investment.

Industry Must Learn To Avoid "Boom or Bust" Gyrations

Much has been said about the volatility of the price of copper. In the past it appears that relatively small excesses of production or deficiencies in supply resulted in wide price swings. Undeniably such price fluctuations have been a deterrent to the growth of consumption. However, some of the past price fluctuations were due to causes beyond the control of the industry.

Over a period of years the copper price on average has not been too high, even though it has fluctuated widely. The period 1953 to 1958 may be representative since it included a year of very high prices and two years of recession. During this period the E&MJ price for domestic copper, delivered to buyers' plants, averaged 32½ cents per pound. This is the mean of the six annual averages which show a low of about 26⅛ cents in 1958 and a high of about 42⅛ cents in 1956. The low was too low and the high was too high—one of the problems of the industry is to determine whether and how these boom or bust price gyrations can be avoided.

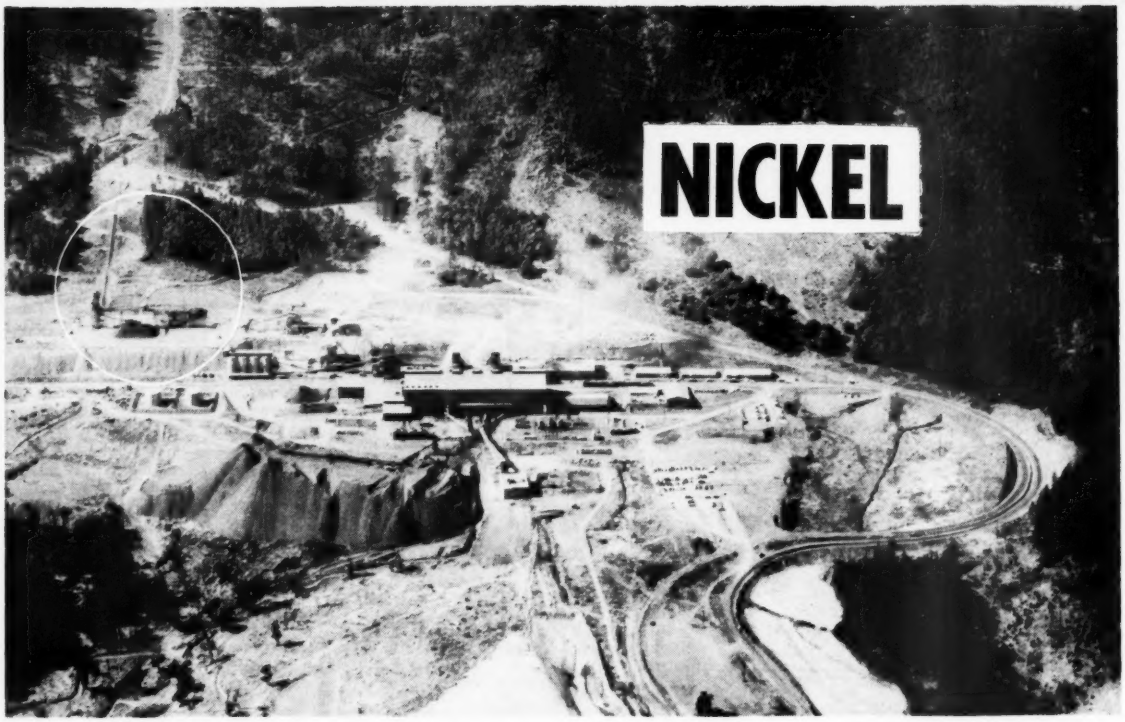
It is, of course, impossible to foretell what conditions the world's copper industry may face during the next decade. However, it appears certain that the money will be found to satisfy the great desire of the world's people for better transportation, communications and housing and for appliances, all of which are copper's best customers. It seems to me that the remarkable increase in industrial production in foreign countries and their favorable balance of payments demonstrates that they have the ability to pay for an increased standard of living. Progress in the United States may be at a slower rate but we are advancing from a much higher plateau.

Big Job Ahead For Copper Industry

The essential ingredients to continued growth in copper consumption are there, but we must find the right recipe if we are to produce a palatable future. Above all, we must try to avoid exaggerated prices, what might be termed the delectable repast of disastrous inflation, which inevitably produce depression prices. Copper must minimize shortages that stunt its growth and overproduction that discourages the capital needed for long term development. We must improve our knowledge of the market, first to ascertain exact end uses, and next, to see that they stay with copper. We must apply to copper to better affect than we have heretofore, the well-known techniques of merchandising which are essential to assure the continued growth of any industry. Copper must consistently and efficiently practice market reresearch, market investigations, and effective technical selling and sales promotion. We must know as an industry what the areas are which can yield consumption gains for copper and its products and what the danger spots are. Implicit in this is a better statistical knowledge of the industry up to the sale of the automobile, the appliance, the house, the electric power. Methods and channels of distribution must be examined and improved wherever found wanting.

It implies, again on an industry basis, an active organization which will propagate the uses of copper and find new ones, and organizations which will equal or better the merchandising techniques of other materials. At the present time most of

(*Continued on page 111*)



Hanna's electric smelter near Riddle, Ore. Crude ore from the mine is transported at 250 tph by an 8400-ft aerial tramway, the bottom of which can be seen to the left

By EARL S. MOLLARD
General Manager
Hanna Nickel Smelting Co.
and The Hanna Mining Co.—Oregon

After years of shortage, the steel and ferro-alloys industries can now be definitely assured that, for the foreseeable future, an ample supply of nickel will be available

THE long range outlook for nickel, that bright, tough, temperature and corrosion resisting metal, appears better than at any time in the past. The expansion of productive capacity during the past few years has guaranteed users of nickel that they no longer need fear curtailment of product development by periodic shortages of the metal.

Productive capacity should exceed 600 million lbs in 1960 and 650 million lbs in 1961. With the free world probably due to establish new consumption records in 1960, there will still be plenty to go around, though the previously anticipated output from Cuban sources, approximately 100 million lbs, may not be available during the year.

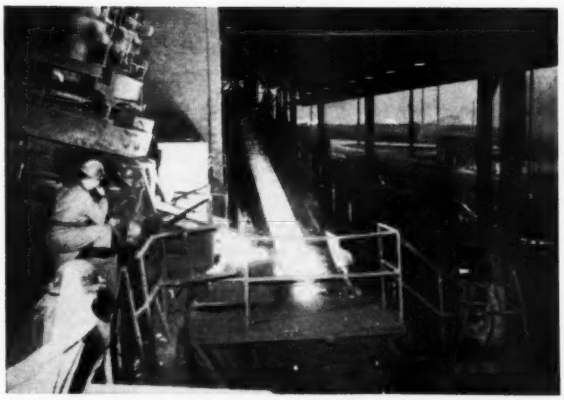
The Thompson mine of International Nickel Company of Canada, Ltd., in northern Manitoba, is expected to be in operation during the year adding some 75 million lbs to Inco's present capacity of over 300 million lbs from their Sudbury operations. Falconbridge's nickel operation, near Sudbury, and Sherritt-Gordon's operations in Saskatchewan, have a combined productive capacity of over 80 million lbs. Hanna Mining Company's operation near Riddle, Ore., has leveled off with a productive output of plus 20 million lbs. The Societe Le Nickel is contemplating expanding operations in New Caledonia to about 50 million lbs annually.

New Family of Nickel-Alloy Steels

The expected increase in iron and steel production in 1960 should result in an almost proportional increase in nickel consumption. In addition to the nickel used in regularly produced high nickel steels, many new nickel-bearing alloys have been developed in the last year. Some of these, such as General Electric's Rene 41 and Astroloy, contain over 50 percent nickel. Inco metallurgists have developed a whole family of nickel-alloy steels containing about 20 percent to 30 percent nickel.

Automobile companies, recognizing the advantages of stainless and high nickel alloys over substitute materials, are again planning on making more use of nickel. In such items as auto trim, bumpers and mufflers, as well as in other spots the addition of relatively minor amounts of nickel increases substantially the useful life

Earl S. Mollard has headed the Hanna operation in Oregon since its inception in 1952. He was formerly located in Hibbing, Minn., as assistant general manager of Hanna iron ore properties. He became a member of the Hanna "family" in 1948, when that firm took over Butler Brothers mining operations where he was manager of mines.



Continuous casting of ferrous nickel from refining furnace into 40-lb pigs

of the part. A recent announcement by a leading auto manufacturer stated that that company expected to use 50 percent more nickel for electro-plated zinc die-cast and steel parts. A new program to determine the best grade of stainless for automotive use is being instituted.

Modern high speed airplanes, supersonic jets and all of the new missiles will require large amounts of nickel to combat heat in the 1500° to 1800° F range, and afford strength in sub-zero temperatures.

Consumption and production figures on nickel are not yet fully available for the year 1959. It is expected the monthly pattern will be very irregular due to an effort to build up inventory in anticipation of the steel strike, then curtailment during the strike period. Stainless steel production for the first half of 1959 was about 90 percent over the same period in 1958. Inventories at the end of the year were probably lower than normal due to the steel strike. Demand during 1960, which is anticipated to be heavy, will also require that inventories be again built up. The outlook for the sales of appliances and kitchen hardware is good and the use of stainless is again becoming very popular in this domestic field.

U. S. Production From Silicates

The Hanna Mining Company's electric furnace operation in Riddle is the only producer of nickel from domestic ores. It was started to alleviate the extreme shortage of nickel which occurred during the Korean War. The smelter was expected to produce 16 million lbs annually from nickel silicate ore, located on nearby Nickel Mountain. This ore body had been known for years and periodic attempts to beneficiate or otherwise improve the ores enough to make operation of the property feasible had been carried on at various times since the late 1800's. The present plant was completed in 1956 and in 1958 produced in excess of 21 million lbs from ore containing approximately 1.5 percent nickel. As the values contained in the ore are not uniform, production, if desired, can be increased or decreased substantially by operating in high or low grade portions of the mine as output demands. Current practice is to blend the ores in a manner which will produce a uniform grade and which will offer the maximum economic long range output.

The Perrin process, being used here for the first time in any commercial sized operation, is, after much mechanical modification, working out very satisfactorily. We believe the Perrin process can handle ores containing extremes in gangue variations with much less loss in recovery than possible in the use of leaching processes.

Benching at Nickel Mountain is at 20-ft vertical intervals

New Markets Will Be Created

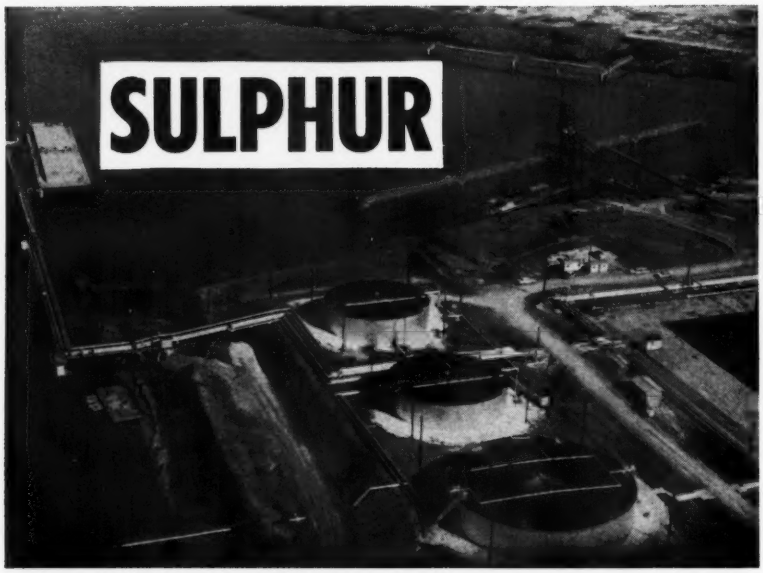
It must be recognized that under present conditions of expanding production, programs will have to be initiated to stabilize these conditions. The research and development programs of International Nickel have, in the past, been very effective in making nickel a necessary item. Today their program of educating the public to the many advantageous uses of nickel, the efforts of their metallurgists in creating new high temperature alloys, and the introduction of nickel to other applications will definitely create new markets unthought of previously and make nickel use more attractive.

The history of nickel is a history of INCO. This company deserves most of the credit for the present day advantages offered by nickel bearing products, and I am sure it will be in the forefront of product and marketing development in the future. The nickel industry is fortunate in having such a leader.

COPPER

(*Continued from page 109*)

the copper producing industry in the United States is recovering from the effects of strikes. This is not peculiar to copper—many other industries have labor troubles. Prior to the strikes it was evident that copper was over-produced. Stocks were growing here and abroad in the hands of producers and fabricators. The overproduction which existed was not very great, probably less than ten percent. Some producers here and abroad had announced curtailments of production. In the future, temporary reductions in demand will no doubt recur. How the individual producers will react to such periods—whether they will try individually to cushion them so as to avoid wide fluctuations in prices—remains to be seen. It is good for the long term future of the copper industry that there is now, and let us hope there will continue to be, a capacity to produce somewhat in excess of the demand. This, together with sound marketing, pricing and production policies, should ensure a future growth of copper which, the writer believes could well be substantially in excess of the past rate.



Beaumont, Texas, facilities of Texas Gulf Sulphur Co. for loading molten and solid sulphur are now being completed

SULPHUR

By CLAUDE O. STEPHENS,
President
Texas Gulf Sulphur Co.

Claude O. Stephens joined Texas Gulf Sulphur immediately following graduation from Louisiana State University in 1932. After service as a field engineer and as manager of the company's Wyoming operations, he became manager of the gas department in 1951. Stephens was elected a vice president the following year and became a director in 1956. He has been president of the company since 1957. In addition to membership in several professional engineering societies, he is on the board of governors of the American Mining Congress.

Although the steel strike had a temporary depressing effect, other parts of the sulphur market showed increases resulting in near record consumption in the United States

WORLD-wide consumption of sulphur reached a record high in 1959—some 16,000,000 long tons—in all forms. This represents a five percent increase over the 1958 year. In this same period the United States registered a ten percent increase in sulphur consumption.

From the Frasch producers' point-of-view it is encouraging to note that these increases were centered in the use of elemental sulphur rather than in pyrites, smelter gases and other forms. On a world-wide basis elemental sulphur accounts for 50 percent of the total consumption and the Frasch portion is some 39 percent.

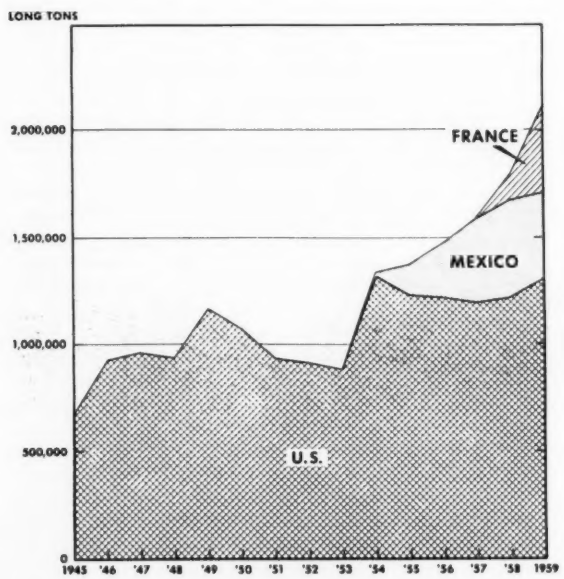


Chart I — Overseas sales by major elemental sulphur producers (excludes sales to Canada, Cuba, Mexico & U. S.)

Production

Since the advent of Frasch sulphur, the United States has been the main sulphur producer in the world. In recent years other countries have also become significant producers of elemental sulphur. Canada and France now produce increasing tonnages from sour natural gas while Mexico has become an important supplier of Frasch sulphur.

Here in the United States large tonnages of elemental sulphur are produced from sour natural gases as well as refinery gases; however, the major supply is from the Frasch mines. The capacity of these mines is greater than present day production; but, due to market conditions, and to reduce inventories, production has been lowered from 1957 levels.

U. S. Frasch production came from the same twelve mines operating in 1958. Duval Sulphur and Potash Co. produced at Orchard, Texas; Freeport Sulphur Co. at Lake Washing-

ton, Garden Island Bay, Bay Ste. Elaine in Louisiana and Chacahoula, Texas. In December, 1959, the Bay Ste. Elaine mine was shut down as the mine became exhausted. The plant is expected to be moved to a new mine at Lake Pelto, La. Work on the Freeport Sulphur Co.'s offshore property at Grand Isle continues and this property is expected to come into production early in 1960. Jefferson Lake Sulphur Co. produced at Clemens and Long Point in Texas and Starks in Louisiana. U. S. producing mines for Texas Gulf Sulphur Co. are: Fannett, Moss Bluff, Newgulf and Spindletop, all in Texas. Production at the Newgulf mine of the Texas Gulf Sulphur Co. continued at a rate much below normal capacity until late in the year when it was allowed to resume at a somewhat higher level.

Recovered sulphur was produced at more than 50 locations in the United States.

The production picture of the Free World's elemental sulphur is shown in Table I for the years 1957, 1958 and 1959 with particular emphasis on U. S. production.

TABLE I

ESTIMATED FREE WORLD ELEMENTAL SULPHUR PRODUCTION
(*1,000 long tons of sulphur*)

	1957	*1958*	*1959*
United States			
Frasch	5,491	4,643	4,550
Recovered	511	640	655
Sulphur ore	87	2	10
Total	6,089	5,285	5,215
Canada	94	184	300
France	32	127	400
Italy	207	191	155
Japan	257	181	220
Mexico	1,018	1,244	1,325
Others	481	495	485
Total	2,089	2,422	2,885
GRAND TOTAL WORLD	8,178	7,707	8,100

TABLE II

ESTIMATED FREE WORLD SULPHUR CONSUMPTION—ALL FORMS
(*1,000 long tons of equivalent sulphur*)

	1958	*1959*
Elemental		
Frasch	5,715	6,200
Recovered	1,100	1,500
Sulphur ores	504	490
From sulphide ores	150	150
Total	7,469	8,340
Other Forms		
Pyrites	5,522	5,550
Smelter gases	1,443	1,350
Anhydrite	489	500
Other materials	324	300
Total	7,778	7,700
GRAND TOTAL—ALL FORMS	15,247	16,040

TABLE III

UNITED STATES CONSUMPTION OF SULPHUR IN ALL FORMS
(*1,000 long tons of equivalent sulphur*)

	1957	*1958*	*1959*
Sales of U. S. Frasch Sulphur	5,005	4,625	5,150
Less U. S. Frasch Exports	1,562	1,571	1,600
Shipments of Sulphur Ore	53	48	10
Sales of Recovered Sulphur	481	599	680
Sulphur Withdrawn from Customers' Inventories	100	0	– 25
Plus Imports of Sulphur	496	591	625
Total Elemental Sulphur	4,573	4,292	4,840
Pyrites (Domestic and Imported)	544	511	525
Smelter Gases	390	360	375
Hydrogen Sulphide and Liquid Sulphur Dioxide	88	92	95
Total Non-Elemental	1,022	963	995
GRAND TOTAL CONSUMPTION	5,595	5,255	5,835

Consumption

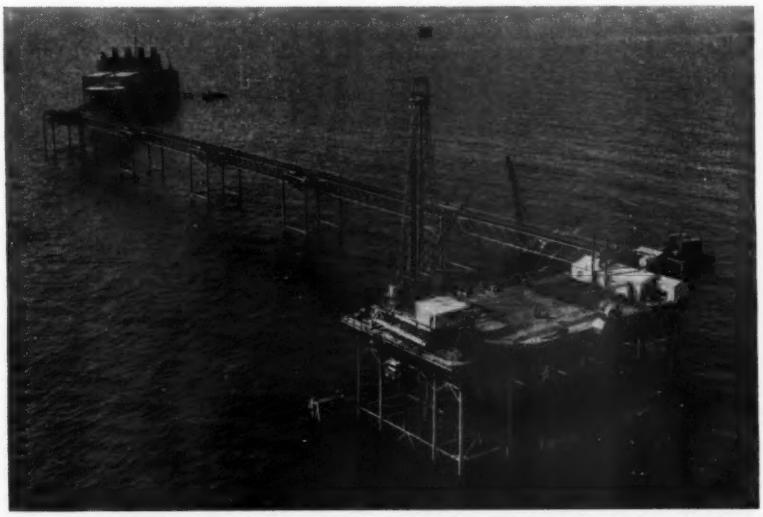
It has been pointed out that the Free World's sulphur consumption is at a record high while U. S. consumption is at a near record level. Table II indicates the world's sulphur consumption for 1958 and 1959.

While total world consumption increased some five percent in 1959 over 1958, the elemental portion increased more than ten percent. Of the elemental portion, world Frasch usage was up some nine percent in this same period, while recovered sulphur registered a 35 percent increase —mostly due to the increased use of French sulphur. Tonnage-wise Frasch showed the greatest increase.

The statistical balance on the sales of U. S. sulphur and the consumption of sulphur in the United States can be obtained from Table III. This table shows that the consumption of sulphur in all forms in the United States has increased some ten percent in 1959 as compared to 1958. Most all of this increased consumption was centered on elemental sulphur. Recovered sulphur is continuing its upward trend of supplying more domestic demands. Another important segment of the domestic consumption is imports of elemental sulphur. Most of these imports are Frasch sulphur from Mexico and while larger tonnages have entered the United States, the upward rate of these shipments has lessened, especially in 1959. For instance, while U. S. elemental consumption increased by almost 13 percent, imports in 1959 increased by less than six percent over 1958. During this same period domestic consumption of U. S. Frasch sulphur increased by more than 15 percent.

In 1958 U. S. Frasch producers formed the Sulphur Export Corp. to sell their sulphur overseas (excluding Canada, Mexico and Cuba). It can be reported that in 1959, overseas sales by the United States was the second best year on record. Chart 1 shows the quantities of sulphur sold in the overseas market by major sulphur producing countries.

(*Continued on page 121*)

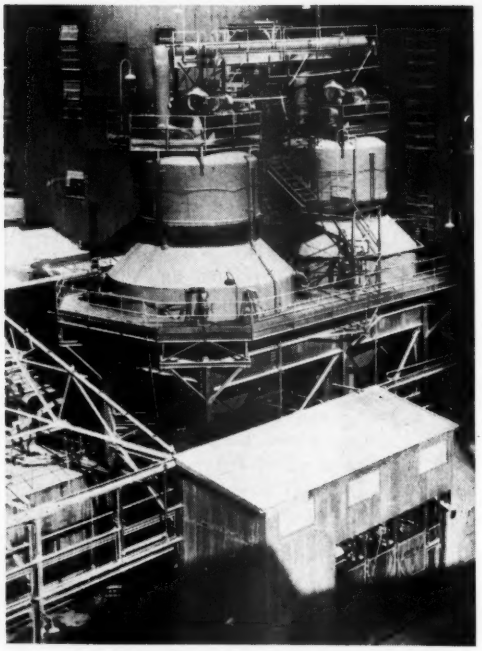


Grand Isle offshore mining plant of Freeport Sulphur Co. is expected to come into production early this year

POTASH

1959 marked the twenty-fifth successive year that deliveries increased over the preceding year. Improved shipments resulted in reduction of producers stocks on hand by midyear to the lowest level since 1953

By E. M. KOLB
Assistant to Vice President,
Marketing
American Potash and Chemical Corp.



Two 22-ft diam potash crystallizers of Swenson design at the American Potash & Chemical Corp., Trona, Calif., plant were added to the recovery unit to increase the size of muriate of potash crystals

THE North American potash industry continued to expand its production capacity during 1959. The first shipments of potash from Saskatchewan in Canada were made early in the year. Six companies operated underground mines near Carlsbad, N. M., and two companies located in California and Utah produced potash from brine. The Farm Chemical Resources Development Corp. in the Carlsbad district, which has completed its first shaft, is proceeding with its research program before constructing a refinery.

Exploration and development progressed in Saskatchewan and in southwest Utah. Potash Company of America, Ltd., completed its refinery at Floral, Sask. The International Minerals & Chemical Corp. continued with the sinking of its shaft near Esterhazy, Sask., while the Delhi-Taylor Oil Corp. continued exploration near Moab, Utah.

A review of the latest statistics published by the American Potash Institute shows an enduring rise in deliveries. Shipments for the first nine months of 1959 by the eight principal American producers, plus imports for agricultural purposes in the United States, Canada and Cuba, were six percent greater in salts and K_2O than for the same period in 1958. Deliveries of potash for nonagricultural purposes showed an increase of 33 percent over last year. Exports by domestic producers to markets outside North America increased approximately 13 percent. Total deliveries for all purposes showed an increase of eight percent in salts and K_2O. Should the indicated trend in deliveries continue during the last quarter of 1959, total deliveries will be approximately 2,700,000 short tons of K_2O, an increase of nearly five percent over 1958. This will mark the twenty-fifth year which has shown an increase over the preceeding year.

While there has been a steady increase in the demand for potash, production capacity remains greater. Substantial stocks were in the hands of producers on June 30, 1958. The U. S. Bureau of Mines, reported the stocks to be 794,000 tons of potassium salts containing 473,000 tons of K_2O. Production in New Mexico was cut back extensively during the summer of 1958 as a result of labor strikes and economic shutdowns. This, along with improved shipments, resulted in a reduction of stocks on hand June 30, 1959, to 446,000 tons of potassium salts, containing 261,000 tons of K_2O. The stocks in producers' hands on June 30, 1959, were the lowest since 1953.

There was a sharp drop in farm income in 1959, and Department of Agriculture economists predict a further decline this year. However, the USDA recently predicted a rise of 10 to 15 percent in primary plant nutrient consumption for 1959, but foresaw "little change from the 1959 level in 1960." The USDA apparently is looking for a leveling off in the long-term rise in plant nutrient use. Potash consumption should continue to show a modest increase.

Processing Searles Lake Brine

In February, 1959, American Potash & Chemical Corp. added two new crystallizers to the potash recovery unit at its Trona plant. These crystallizers were installed to increase the crystal size of the "Trona" muriate of potash.

The Trona process consists of concentrating brine from Searles Lake and recovering potash and borax by cooling the hot concentrated liquor. The potash is crystallized in three stages of cooling in which the liquor is supersaturated with respect to borax in the final stage, requiring rapid crystallization and separation of the potash. The new crystallizers combine the first and part of the second stages of crystallization where the temperature is kept above the borax saturation point. These crystallizers, which are of Swenson design,

Edward M. Kolb joined the sales staff of American Potash & Chemical Corp. in 1932. From 1934 to 1939 he managed the sales office of the company in Baltimore, Md. On his return to New York he was made manager of potash sales. In 1945, he was made general sales manager, and early in 1959, assistant to the vice president, marketing.

are 22 ft in diameter to allow adequate residence time for crystal growth. In addition to the retention time, the quantity of solids in the slurry is controlled in order to product potash crystals between 30 and 50 mesh screen size. The coarse crystals are separated from the mother liquor on a DSM screen and the liquor is sent to the previously existing second and third stage crystallizers for further removal of potash. Borax is subsequently removed in the borax plant by seeding. Spent liquor is mixed with the incoming brine for further concentration.

New Leaching System More Efficient

Coarse potash from the DSM screen is leached in the mother liquor from the borax plant before the liquor is mixed with the lake brine. This new leaching system, which was part of the crystallizer installation, is a more efficient method of removing sodium chloride impurities from the potash. Previously, a water dilution was used for sodium chloride control, but it placed an added unnecessary load in the concentration process The coarse potash is separated from the leach liquor on a flat bed Oliver filter. It is then dried and stored for shipment. The new product is dust-free and of relatively uniform crystal size.

Considerable planning went into this new unit. In fact, two methods were proposed. Research work was carried out simultaneously on both methods until an accurate evaluation could be made of both. The planning and research paid off as the units were put on stream with a minimum of difficulty.

Bonneville, Ltd., at Wendover, Utah, reports no changes in basic plant or process during the past year. Bonneville recovers the potash values from salts recrystallized by solar evaporation. During the year the granulation unit was discontinued.

Utah Deposits Have Important Future

Delhi-Taylor began a potash exploration program in Utah in 1953. Since that time, the company has maintained a continuous development program on its potash discovery in that state. The Cane Creek deposit, southwest of Moab, Utah, has been selected for first development, and work is continuing on a program to define more completely the limits of the deposit and to obtain information toward mine and processing plant design. Currently, an active drilling program is under way. The results to date have established a large high grade deposit of potash that promises to make Utah an important future domestic source of this vital material.

Duval Sulphur & Potash Co. reported that there have been no changes or improvements worth noting in the operation of the potash mines during the year 1959.

Farm Chemical Resources Development Corp. of Carlsbad, N. M., has completed sinking a 15-ft diam concrete - lined man - and - materials shaft 1695 ft. Stations were cut at the carnallite and sylvinite levels. Sufficient ore has been mined for tests and research purposes. A laboratory and pilot plant program is underway for the development of a satisfactory process flowsheet. A production schedule will be established upon completion of the research and development work.

International Minerals & Chemical reported that with mine production geared to an all-time total tonnage record for 1959, several daily records were set, broken and new ones hung up. Present record tonnages for 24-hr stand at 12,008 tons of sylvinite, 3384 tons of langbeinite ore, and a total daily tonnage record of 14,606.

First pillar mining was done on the langbeinite level, at 850 ft. A recently developed method of girdling the pillars was used. This is designed for improved safety, lower production costs and a possible total extraction of up to 94 percent.

First Application of Ammonium Nitrate Blasting

Langbeinite mining was converted to ammonium nitrate blasting in September and the balance of the mine will adopt the system by early spring. Bulk loading of holes is accomplished by an air-placement machine and only a small amount of dynamite is used to act as a booster. This is the first application of ammonium nitrate blasting to the potash industry.

On the sylvite level the use of belt conveyors was extended to include panel haulage.

Low height mining equipment was installed to permit economical mining of reserves down to 4½ ft in height, greatly expanding the potential life of the property.

A central dispatching system was installed in the mine to expedite the movement and maximum utilization of haulage equipment and the mine radio-phone system was expanded to surface positions including offices of the mine manager, mine supervisors, and the hoistmen.

In the processing plants, the control system was strengthened in all sections to improve both chemical and physical specifications. This was coupled with a general program of stepped-up efficiency to keep pace with the mining operations.

A Bird-Humboldt basket centrifuge was applied to the final step in dewatering langbeinite products. Capacity for granular muriate was increased by installation of a second flotation unit, and Oliver diaphragm slurry pumps were installed on the 100-ft thickeners to provide continuous slime withdrawal and effect better recovery in the muriate section.

A redesigning of circuits to the Ozark evaporators resulted in increased capacities for pure KCl, and potassium sulphate, and provide a higher concentration of magnesium with reduced impurities.

In the pure KCl section, the use of steam condensate in the final wash for the finished product centrifuge resulted in improved purity of the product. An innovation in this section was the installation of gamma ray control of the KCl slurry mixer to provide constant and automatic density control.

In addition to the improved feed provided by the Ozark change for the MgO-HCl section, improved feed, more efficient operation, and greatly reduced maintenance costs were achieved by the replacement of the roto-louvre dryer with a tetrahydrate dryer. This conditions the magnesium chloride flake feed to the section.

Special Instrument Aids Kiln Operators

Another first for this area and the potash industry came in the use of infrared rays in high temperature kiln maintenance control. This was accomplished by the use of both photography and observation through a "Sniperscope," an instrument developed during the war which converts the invisible infrared rays into visible fluorescence.

National Potash Co., the newest of the Carlsbad producers, completed its third year of operations in 1959. Mining in the tenth ore zone, 700 to 1000 ft deeper than other producers in the area, National mines almost entirely by conventional blasting methods, conveying the severed ore to the shaft area by belt conveyors.

During the year this producer installed a second rotary gas-fired drier to remove moisture from the ore before treatment, thereby improving its handling characteristics, and additional desliming facilities in its re-

Underground main haulage level and rotary car dumper at Southwest Potash Corp. near Carlsbad, N. M.

finery to assist in the recovery of fine particles of potassium chloride. The particles so recovered are then leached and recrystallized by vacuum crystallization. National also installed another Struthers-Wells low temperature crystallization unit late in the year, bringing to four the number of crystallizers used in its process.

Earlier in the year, in response to the increasing demand for larger particle sizes, a second compaction unit and additional screening facilities were added to amalgamate fine particles and produce larger quantities of the popular "coarse" product.

In August of 1959, National entered into a contract with Southwest Potash Corp. calling for the purchase of ore produced by Southwest at its mine approximately 20 miles from National's Lea County property. Daily deliveries under this contract began in November with the ore being transported by rail from Southwest's minehead to new unloading facilities at National's refinery, where it is blended with ore from the National deposit before beneficiation.

Consumption Expected to Remain High

PCA, according to its June 30 annual report, had a moderate increase in production at its Carlsbad plant and was, in addition, successful in effecting some reduction in inventory. The company reported that it delivered a sales tonnage which represented an increase in deliveries over the preceding year somewhat in excess of 18 percent and stated that contract bookings for the year ending June 30, 1960, indicated that continuation of heavy consumption appeared to be in prospect.

Operations by Potash Company of America, Ltd., a wholly-owned subsidiary located near Saskatoon, Sask., commenced in the spring of 1959, but a series of mechanical problems and water leakage in its mine shaft caused a shutdown of operations in November. The company has engaged the services of Cementation Co. (Canada), Ltd., to work on its water problem during the period of shutdown.

Operations at Southwest Potash continued at a normal pace during the greater part of the year. Mining activity was accelerated during the last quarter as the result of the contractual agreement to sell crude ore to National. Necessary ore loading facilities and railway spurs were installed in time to commence shipments to the National refinery toward the end of November. Additional loading machines, shuttle cars, drills, mine cars, locomotives, and other equipment was purchased or is being fabricated to take care of the increased mine production requirements.

Minor factors which contributed to improved operations in 1959 were: (1) conversion of all double-boom drills to single-boom drills, (2) switching to a Getman three-wheel jeep with Deutz diesel engine, and (3) installation of an automatic bit grinder.

Processwise there were no significant operating changes and all efforts were directed toward maintaining high quality muriate products.

Warehouse Has Unobstructed Storage Area

United States Potash Co., Division of U. S. Borax & Chemical Corp., reported that its No. 5 warehouse, for the storage of finished products at the refinery, was one of the larger construction completions of the company in 1959. The building is of the type adopted in the early thirties—a concrete floor and buttressed walls on which a steel superstructure and roof are mounted to provide a completely unobstructed storage area. From an engineering standpoint, it is interesting to note that the development of free-flowing products in later years has lowered the angle of repose of refined potash, which has consequently added one more factor to be overcome in storage. A game of football could be easily played under the roof of warehouse No. 5, where modern conveying equipment and mechanisms provide up-to-date means for filling and recovery. There has been a trend in recent years to concentrate shipments into seasons, and several plants in the Carlsbad area can now load and ship trainloads of their products each day; a movement of refined chemical products in quantities which is probably unequalled in any other section of chemical production for a single product.

A number of controls have been introduced into processes throughout the industry which increase the efficiency of operators and deliver a better product to the customer.

The New Mexico State Legislature in 1959 took notice of some inequities in the State tax structure as it related to potash mining and made an adjustment, which should tend to equalize the burden as it relates to this extractive industry.

STRATEGIC METALS

(*Continued from page 101*)

hope in the promise of our Government to maintain "a healthy domestic mining industry." The Government's policy in regard to the strategic metals industry has probably best been summarized in these words of the Secretary of the Interior: "As a general premise we believe that we should not directly subsidize or otherwise support a domestic mineral industry without defense justification or in the absence of a reasonable anticipation that, through research or through increased requirements, the producing industry will become fully commercial."

We have, however, apparently adopted a policy of leaving our minerals in the ground and relying on overseas sources which would not be available in times of emergency. So ends the monotonous story of the passing of an important domestic industry.

Bethlehem contact men move fast, talk sense, work right alongside you

Here, one of our teams tests the anchorage capacity of a Bethlehem Roof Bolt assembly. If you're interested in learning more about roof bolts, remember that our men are ready to do a lot more than just talk. They'll help you with the original installation and testing of mine roof bolts and accessories. Just let us know where and when.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
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BETHLEHEM STEEL

BETHLEHEM STEEL

SILVER

The United States Treasury was again the dominant influence on the industry in 1959. World consumption continued strong, exceeding production, with the balance being made up primarily by sales from Treasury stocks of free silver and from other accumulated stocks

By H. B. JOHNSON
Manager, Sunshine Mine
Sunshine Mining Co.

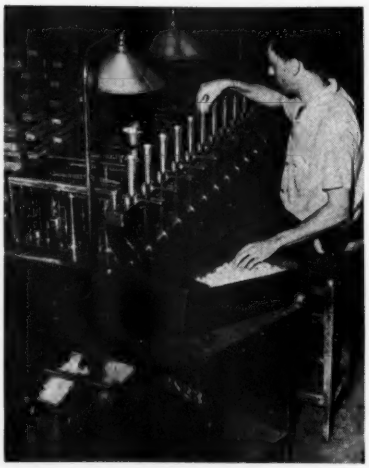
WORLD consumption of silver in industry, including the arts, and for coinage has been increasing in recent years and has averaged over 250 million oz per year. In 1959 world uses are estimated at 296 million oz. The United States is by far the largest consumer in the world with about half of the total usage. U. S. consumption in 1959 is estimated to be 140.7 million oz.

Use as Sterilizing Agent Among New Applications

In addition to the long established uses of silver for such items as silverware, jewelry and ornamental ware, which should continue to increase with the population growth, industrial uses for silver are growing and exceed these traditional uses. The photographic industry is the most important single user of silver employing photo-sensitive silver salts for film and sensitized paper. Silver solders and brazing alloys have become the second leading application of silver, and the use of these bonding materials has become very important to many industries.

In the electrical industry, silver is of increasing importance. Its use in low-resistance contacts has application in many phases of the industry. Growing demand for silver is found in the ceramics industry which is developing a variety of uses. The battery industry, where recent developments of silver-zinc, silver-cadmium and other silver-type batteries is indicating a growing demand.

The water sterilization characteristics of silver have been known for years, but not until recently has its use as a sterilizer been developed commercially. Several applications in



Silver coinage is increasing throughout the world. While other metals might serve mechanically, the demand is for coins with intrinsic value

using silver for producing odor-free, taste-free disinfected water are on the market with a large potential outlet.

Silver is also used in aircraft and diesel engine bearings, atomic energy power reactors, and for many other minor industrial, scientific, dental and medical needs.

H. B. Johnson is a graduate of Michigan College of Mining & Technology. Although his college training was interrupted by 2½ years of service in the U. S. Army Air Corps during World War II, he obtained his degree in mining engineering in 1946. His mining career began at Bilharz Mining Co., Baxter Springs, Kans., where by 1949 he had become mine superintendent. Johnson then joined Sunshine as mining engineer, advancing subsequently to mine superintendent, and in 1956 became manager of the Sunshine mine.

Increasing Usage as Legal Tender Outside U. S.

World requirements for coinage in recent years have averaged about 75 million oz annually, nearly half of which has been coined by the United States. In 1959 world coinage used about 84.2 million oz of silver, of which the United States coined an estimated 40.7 million oz. The use of silver coinage is increasing throughout the world. Not only are more coins required for the general demand of a growing population, but increasing numbers of vending machines and other coin-operated devices require more and more coins. While other metals might serve mechanically, the demand is for coins with intrinsic value.

In the United States there is currently over 1¼ billion oz of silver in the form of dimes, quarters, half-dollars and silver dollars in circulation outside of the Treasury. This is an increase of over 50 percent of the amount in circulation in 1950 whereas the population increase in the corresponding period was about 15 percent.

In the past few years several European nations, such as Germany, France and Italy, have introduced silver coinage, and there are indications that others are considering similar moves including Great Britain, which demonitized its silver coinage shortly after World War II. These coinage requirements will add to the demand for silver in coming years.

With world requirements for silver at 250 million oz or more annually, free world production of silver has

averaged less than 200 million oz per year over the last five years. In 1959 an estimated 195.6 million oz were produced in the free world. Production in the United States in 1959 is estimated at 24 million oz compared with an average production of 36.5 million oz during the preceding five years. U. S. production was reduced by strikes in the non-ferrous industry, particularly in the copper industry during the last half of the year. During this time several million oz of by-product silver were not mined from the mines on strike. Also, in some areas such as the Coeur d'Alene district, silver mined during this period could not be received for treatment at the struck smelters, but was stockpiled. Most of these stockpiles of silver concentrates or silver-bearing concentrates began to move to smelters by mid-December as settlements of the strikes were effected.

Price Stays Relatively Constant Despite Rising Demand

The New York price of silver started the year at $0.89⅞ per oz and advanced to $0.91⅜ on March 4. Quotations remained at this level for the balance of the year except for a few days in late August and early September, when the price rose to $0.91⅝ per oz as a result of a short trucking strike in San Francisco, which meant U. S. Treasury sales of silver would be made from the Denver mint with additional handling charges. The average New York price for the year was $0.91.2 per oz, the highest yearly average since 1920.

The London spot silver market opened the year at 75⅝ pence per oz, equivalent to about $0.88 7/10 U. S., and advanced to 80¼ pence in mid-October, where it remained through November and December. This high was equivalent to about $0.93¾ U. S., varying with the rate of exchange. The average London price for the year was 78.8 pence per oz.

The tight position of the silver market, when the demand for silver by industry and for coinage far exceeds production, is caused by policies of the U. S. Treasury in regard to sales from its stocks of free silver. Under the Act of Congress of July 31, 1946, the Treasury is required to receive all newly mined domestic silver offered to the mint and pays for 70 percent of the silver tendered at the monetary price of $1.29 per oz. This silver is coined into silver dollars, or retained as bullion, as backing for silver certificates issued against it. The remaining 30 percent is retained by the Treasury without payment, as so-called seigniorage or free silver, and is available for minting into subsidiary coins or is available for sale to industry.

Under the 1946 Act, the Secretary of the Treasury is permitted to sell this free silver at not less than $0.90½ per oz to domestic industry. The selling price set by the Treasury is $0.91 per oz at the San Francisco Mint, or $0.92¼ including railway express charges at the New York assay office. By purchasing in San Francisco and trucking to New York, the effective New York price has become $0.91⅜ per oz. This has become the effective "ceiling" price of silver on the world market. From 1946 through 1958, Treasury sales under this Authority amounted to approximately 20 million oz, most of which have occurred from 1955 on. In 1959, it is estimated that the Treasury sold 33 million oz from these stocks of silver.

U. S. Treasury Faces Future Shortage for Coinage

The Treasury stock of free silver on January 1, 1959 was 203 million oz and on December 31 was 175.1 million oz. Purchases of newly mined domestic silver were estimated to be 1 million oz for the first eleven months in 1959. During the preceding five years, these purchases averaged about 23 million oz annually, of which 6.9 million oz annually were available as free silver. Subsidiary coinage requirements during this period averaged 36.5 million oz annually, and sales by the Treasury averaged 3.8 million oz per year.

Thus, in these preceding five years, the Treasury has reduced its stock of free silver by minting into subsidiary coinage or through sales to industry, by 202 million oz, while adding to these stocks only 34.5 million oz with purchases of newly mined silver. This was made possible by the return of about 369 million oz of lend-lease silver lent to foreign governments during World War II, which was added to the free silver stocks. The net effect was to increase the free stocks by some 153.8 million oz.

The repayment of lend-lease obligations has now been largely accomplished, and the decrease of Treasury free stocks will continue unless the policies of the Treasury department are revised or unless the Congress revises the Silver Purchase Act. To maintain this supply of silver for future coinage needs, forestalling the necessity of being forced into the open market at undoubtedly higher prices, the Secretary of the Treasury should cease such sales of silver, or under his discretionary authority make such sales at not less than the monetary price.

The Congress, which has reduced the seigniorage on silver purchase to the present 30 percent, should continue this reduction until the seigniorage has been eliminated.

With world requirements for silver at 250 million oz or more annually, free world production has averaged less than 200 million oz over the past five years

MOLYBDENUM

Production and consumption in 1959 were up markedly from the previous year, and 1960 is expected to bring further significant increases in consumption

By J. Z. BRIGGS

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Division of American Metal Climax Inc.

J. Z. Briggs received her S.B. degree in engineering from Stanford University and was later awarded an engineering degree in mining at the same school. Finding jobs for women miners difficult to obtain in the depression years, she went to Europe for further study and earned a doctorate of mining sciences at Leoben Mining Institute, Leoben, Austria. Her professional work has been predominantly in metallurgy having spent ten years working on high-quality steels at the Crucible Steel Company of America and continuing in similar work with Climax for the past 15 years.

THE keynote for molybdenum in 1959 was adequacy of supply. Production in the free world recovered noticeably from the 1958 low but did not come up to 1956 and 1957:

	Millions of Pounds of Molybdenum (Concentrate)			
	1956	1957	1958	1959 (est.)
Free World Including USA	63	67	46	58
USA Alone	57	61	41	52

About a third of the molybdenum produced in recent years has been a by-product of copper mining. In 1959 this by-product output was hurt by strikes, notably a one-month strike at Braden Copper Co. in Chile, and about a four-month strike of domestic copper mines producing by-product molybdenum. To offset this, Climax Molybdenum Co. went from a five to a seven-day week about midyear.

Apparent free-world industrial consumption increased both in the United States and abroad:

	Millions of Pounds of Molybdenum			
	1956	1957	1958	1959 (est.)
Free World	62	60	45	58
USA	39	35	27	34
Outside USA	23	25	18	24

(The figures for apparent industrial consumption outside the USA are based on foreign production and USA exports.) The serious effect of the 116-day steel strike in the USA is not clearly evident as it was outbalanced by the economic recovery in the first half of 1959. Foreign free-world consumption also recovered markedly from 1958's low, which was attributed in part to drawing down of inventories. A release of over a million pounds of molybdenum from the British government stockpile during the year was taken up by British converters.

Growing By-Product Production

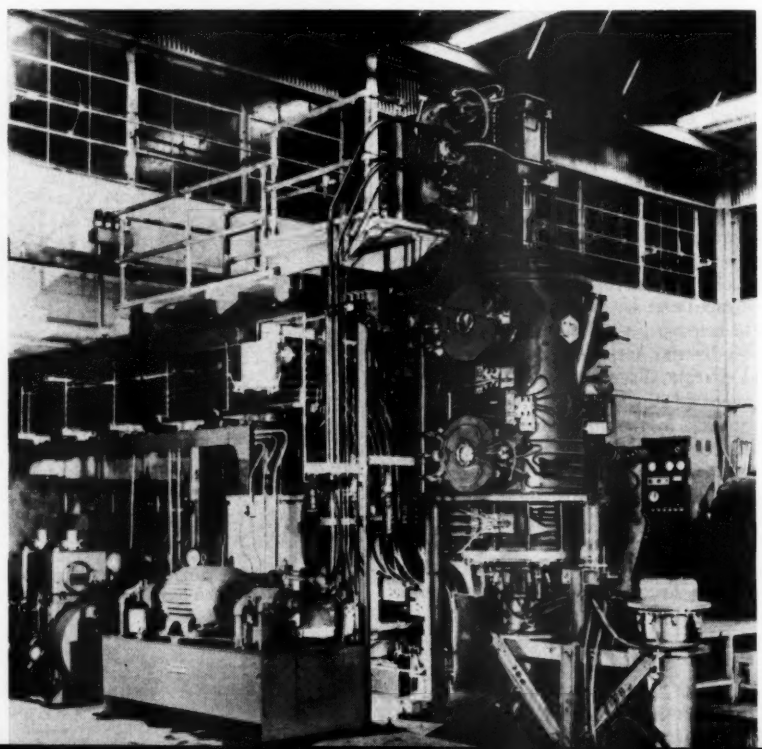
One factor in achieving adequacy of supply has been the growing contribution from by-product sources. Among new by-product producers in the USA that might be mentioned are Inspiration Consolidated Copper Co. and Duval Sulphur and Potash Co. For instance, production of molybdenum from Duval's Twin Buttes mine in Arizona started in 1959 and is expected to be significant in the future.

In addition, Chilean by-product production is expected to increase, and presumably this molybdenum will be exported to countries outside the USA. Molybdenum production from Chuquicamata was very small in 1958, but it picked up materially in 1959 and continued growth is expected. Anaconda's El Salvador mine, also in Chile, is slated to come into production in 1960 with a sizable output of molybdenum.

Markets for Molybdenum

Frequent headlines on new and spectacular applications of molybdenum sometimes tend to obscure the key fact that by far the largest uses of molybdenum are in the iron and steel field. At the start of 1959, the

A vacuum-arc melting furnace at Climax's Coldwater, Mich., plant, opened in 1958 to produce ingots of metallic molybdenum and other refractory metals. Typical of the latter is a 70 percent molybdenum-30 percent tungsten alloy developed for missile application and introduced on the market in 1959



Bureau of Mines introduced a new breakdown of USA consumption that gives a better view than past statistics as to just where molybdenum is going (Table I).

Table I. USA Consumption of Molybdenum by Class of Manufacture In First Half of 1959

Class	Thousands of lb of contained molybdenum
Steel	
High speed	1,502
Hot-work tool	146
Other tool	293
Stainless	2,136
Other alloy*	10,155
Steel-mill rolls	485
Gray and malleable castings	1,512
Welding rods	127
High-temperature alloys	617
Molybdenum powder	
wire, rod and sheet	500
Other (forging billets, etc)	442
Chemicals	
Pigments (ceramic and paint)	282
Other color compounds	198
Catalysts	141
Miscellaneous**	355
TOTAL	18,891

* Includes quantities that were believed used in producing high-speed steels because some firms failed to specify individual uses.

** Includes magnets, other special alloys, friction material, lubricants, pesticides, refractories, packings, etc.

A major item in the "other alloy steel" classification, which is the largest individual value, remains the low-alloy steels used for various engineering applications, such as gears and shafts, where two trends have been accentuated in the past few years. One is the increasing adoption of higher molybdenum contents in carburizing steels. There are now five AISI grades in this category that have become standards as a result of the magnitude of their tonnage, and which to date have been used largely for automobiles. They have gained this position as a result of their properties, ease of handling and economy as compared to previously used grades. A second feature is the increasing use of alloy-steel plates and sections furnished by the steel mills in the heat-treated condition. The most popular of these steels contains about 0.5 percent molybdenum along with other alloying elements. Due to their strength and toughness, these grades have found the most diversified applications ranging from power shovels to large stationary gas containers.

Molybdenum consumption for high-speed and stainless steels is not new but has been growing at an increasing rate. Since the introduction of the first modern molybdenum high-speed steel in the early 1930's, molybdenum types have become increasingly important because of their performance and economy. For a number of years they have accounted for more than 80 percent of the total high-speed steel output. In stainless steels, molybdenum makes a unique contribution to corrosion resistance, so the types with two- to four-percent molybdenum have long been preferred for applications involving severe corrosion. They have made possible many chemical processes that would not be feasible with the molybdenum-free types.

Gray cast iron is another field where the benefits of molybdenum—effectiveness, ease of addition and economy—have led to constantly increasing consumption. Recently, and particularly in a 1959 paper from Case Institute of Technology, information has become available to prove that molybdenum increases the hot strength of cast iron as much as it does that of steel. As a result, new applications for stressed parts at moderate temperatures have been opened to cast iron.

1960 Predictions

Production and consumption in 1960 will probably be considerably higher than in 1959. As a result of the longer work week, Climax production is expected to be greater in 1960 than in 1959. By-product production should also be greater as a result of new sources and the possible increase in copper production.

Molybdenum consumption in 1960 is expected to be significantly higher than in 1959. To compensate for the alloy-steel production lost during the long 1959 strike, it is anticipated that molybdenum consumption in the USA steel industry will be high for at least the first two or three quarters of 1960. Economic activity in the free world outside the USA was much higher towards the end of 1959 than at the start, and is expected to maintain this high level. This improved industrial production will doubtless be reflected in consumption of molybdenum.

SULPHUR

(*Continued from page 113*)

Stocks

The world's major stocks of sulphur are maintained by the U. S. Frasch Industry. At the end of 1958 U. S. Frasch stocks were over 4,400,000 long tons and these stocks declined to about 3,900,000 long tons by the end of 1959.

As mentioned previously, this decrease was brought about by increased consumption and maintaining about the same production level in 1959 as in 1958.

Molten Sulphur

The shipment of Frasch sulphur in molten form continued to expand during the year. While a great many of the recovery plants have been shipping their sulphur molten in tank cars or trucks for many years the greatest part of the Frasch sulphur still moves in solid form. In 1959 the Texas Gulf Sulphur Co. installed a molten terminal at Cincinnati. Barges that come up the Ohio River discharge molten sulphur into storage tanks from which it is trucked or sent by rail to nearby consumers. Molten sulphur also is handled by Frasch producers at Boston, Houston, Mobile, St. Louis and Tampa. The Texas Gulf Sulphur Co. is just completing a new loading terminal at Beaumont adjacent to its Spindletop mine. The facilities will accommodate ocean vessels for solid or molten movements. The Freeport Sulphur Co. has shipped most of its sulphur (either molten or solid from Port Sulphur on the Mississippi River and when new production comes in at Grand Isle it will move to Port Sulphur in molten form through a combination of about seven miles of pipe line laid on the ocean floor and barges.

Price

Posted prices remained $23.50 per long ton, f. o. b. mine, for bright sulphur and a dollar less for dark. The year 1959 was one of intense competition in the sulphur industry, prompted by increased foreign production and sales. Aiding foreign sales in the United States has been the low freight rates on foreign vessels—U. S. producers, by law, must ship in U. S. flag ships to American ports at substantially higher rates. At year end some firming of the foreign freight rates was noted.

Although the steel strike had a temporary depressing effect, other parts of the sulphur market, such as fertilizers and chemicals, showed increases resulting in a near record sulphur consumption in the United States in 1959. While price competition was hard on the producers, it created a larger market for elemental sulphur and a market that should expand further in coming years.

Sales of Coal Mine Equipment

Sales of face equipment increased over those of 1958 but did not reach the '56–'57 level. In terms of capacity, jigs continued to rank first in preparation equipment sales, with two-thirds of all coal cleaning equipment sold in 1959 being for addition to, or replacement of, existing facilities

By W. H. YOUNG and R. L. ANDERSON
Chief, Bituminous Coal and Lignite Section, and Supervisory Commodity-Industry Analyst
U. S. Bureau of Mines

W. H. Young and R. L. Anderson need no introduction to Mining Congress Journal readers. Their reports on equipment sales have been closely studied by the coal industry for many years. We are proud to once again present their annual review.

W. H. Young

R. L. Anderson

Dr. Young joined the U. S. Bureau of Mines as an economist in the Coal Economics Division. Since 1944 he has served as chief of the Bituminous Coal Section.

After several years experience with a firm of consulting mining engineers, R. L. Anderson joined the Government in 1934. Since that time he has been employed by various agencies having to do with coal and at the present time is a commodity-industry analyst with the Bureau.

SHIPMENTS of mechanical loading equipment for underground use in coal mines in the United States, in terms of capacity, increased 17 percent in 1959 from 1958. The capacity of mechanical cleaning equipment sold for use at bituminous coal mines was 13 percent less in 1959 than in 1958.

This survey was made possible by the cooperation of manufacturers of mechanical cleaning equipment for bituminous coal mines and of mechanical loading and supplementary haulage equipment and coal-recovery augers for use in all coal mines in the United States. Information from trade journals also was used.

Sales of mechanical loading units, coal-recovery augers, and supplementary haulage equipment in 1959, as in previous years, represent shipments during the year. Of the total capacity of mechanical cleaning equipment sold in 1959, 50 percent was placed in operation during that year; the remainder (50 percent) will be installed later.

Mechanical Loading and Mining

Bituminous coal and lignite mechanically loaded in underground mines decreased from 244,000,000 tons in 1958 to an estimated 239,000,000 tons in 1959. Production at strip mines increased from 116,000,000 tons to an estimated 123,000,000 tons and at auger mines from 7,000,000 to 8,000,000 tons during the same period.

Table I shows data on bituminous coal and lignite production, by methods of mining, and mechanical cleaning for 1957–59, inclusive. The percentage of total production of bituminous coal and lignite in the United States, 1937–59, by type of mining and loading is shown on figure 1. During 1959, more than 90 percent of the total output was mechanically loaded at underground mines, loaded by power shovels at strip mines, or mined by augers along highwalls in strip mines.

Underground production of bituminous coal and lignite, by methods of loading, is listed in table II. The estimated percentage of underground production mechanically loaded in 1959 was higher than in the preceding year.

Auger Mining. Augers are used for coal recovery along highwalls in strip mines and on bench operations where coal cannot be economically mined by stripping. Separate data on the number of augers in use and the tonnage produced by auger mining were first collected for 1952.

TABLE I. Bituminous coal and lignite production, by methods of mining and by mechanical cleaning, in the United States, 1957–59, inclusive

	1957		1958		1959[1]	
	Thousand net tons	Percentage of total	Thousand net tons	Percentage of total	Thousand net tons	Percentage of total
Hand-loaded underground	54,912	11.1	43,311	10.6	40,000	9.8
Mechanically loaded underground	305,737	62.1	243,573	59.3	239,000	58.3
Mined at auger mines	7,946	1.6	7,320	1.8	8,000	1.9
Mined by stripping	124,109	25.2	116,242	28.3	123,000	30.0
Total production	492,704	100.0	410,446	100.0	410,000	100.0
Mechanically cleaned	304,027	61.7	259,035	63.1	260,000	63.4

[1] *Preliminary.*

TABLE II. Underground bituminous coal and lignite production, by methods of loading, 1957–59, inclusive

	1957		1958		1959[1]	
	Thousand net tons	Percentage of total	Thousand net tons	Percentage of total	Thousand net tons	Percentage of total
Mobile loading machines:						
Loading direct into mine cars	24,797	6.9	13,658	4.8	(2)	(2)
Loading onto conveyors	14,419	4.0	13,563	4.7	(2)	(2)
Loading into shuttle cars	197,506	54.8	150,792	52.6	(2)	(2)
Continuous mining machines	53,783	14.9	56,373	19.6	(2)	(2)
Scrapers	81	—	11	—	(2)	(2)
Conveyors equipped with Duckbills or other self-loading heads	2,699	.7	1,550	.5	(2)	(2)
Hand-loaded conveyors	12,452	3.5	7,626	2.7	(2)	(2)
Total mechanically loaded	305,737	84.8	243,573	84.9	239,000	85.7
Hand-loaded into mine cars	54,912	15.2	43,311	15.1	40,000	14.3
Total underground production	360,469	100.0	286,884	100.0	279,000	100.0

[1] *Preliminary.*
[2] *Included with "Total mechanically loaded."*

Reports from four manufacturers of coal-recovery augers show that 47 augers were shipped in 1959 compared with 45 in 1958, an increase of four percent. All augers shipped in 1959 were for surface use. Table III shows coal-recovery auger shipments in 1955–59, and table V the number in use in 1958 and shipments in 1959, by states.

Types of units sold. Table III lists the units of mechanical loading and mining equipment shipped for use at coal mines in the United States, 1955–59, inclusive. Shipments of continuous mining machines, coal-recovery augers, shuttle cars, and gathering and haulage conveyors increased, while room or transfer conveyors and bridge conveyors decreased in 1959 from 1958. Shipments of mobile loading machines were the same in both years. There were no scraper loaders shipped in 1959.

Exports of underground mechanical loading equipment in 1959, in terms of capacity, amounted to 17 percent of the shipments to mines in the United States compared with 15 percent in 1958.

Types of mechanical loading equipment sold compared with units in use. Table IV shows the trend in demand for various types of mechanical loading equipment. Continuous mining machines were first used in 1948; however, they were not shown separately until 1952. The number in use has increased every year from 1952 to 1958. Shipments of continuous mining machines in 1959 were 21 percent of the number in use in 1958. Mobile loading machine shipments in 1959 were three percent of the number in use in 1958.

Table V shows the number of mechanical loading units and coal-

TABLE III. Units of mechanical loading and mining equipment sold for use in coal mines, as reported by manufacturers, 1955–59, inclusive

Type of equipment	1955	1956	1957	1958	1959	Change from 1958 (percent)
Bituminous coal and lignite mines:						
Mobile loading machines	120	239	209	97	95	– 2.1
Continuous mining machines	109	154	168	107	140	+ 30.8
Coal-recovery augers	65	89	53	42	47	+ 11.9
Scrapers[1]	—	—	—	1	—	—
Shuttle cars	348	560	488	181	233	+ 28.7
Gathering and haulage conveyors[2]	78	137	172	97	118	+ 21.6
Room or transfer conveyors[3]	143	232	159	92	65	– 29.3
Bridge conveyors	(4)	128	96	66	61	– 7.6
Anthracite mines (Pennsylvania):						
Mobile loading machines	1	—	1	—	2	—
Continuous mining machines	—	—	1	—	—	—
Coal-recovery augers	1	—	2	3	—	—
Scrapers[1]	2	—	—	—	—	—
Shuttle cars	8	2	2	—	—	—
Gathering and haulage conveyors[2]	3	—	2	—	4	—
Room or transfer conveyors[3]	7	19	45	21	23	+ 9.5
Bridge conveyors	(4)	—	1	—	2	—
Number of manufacturers reporting	22	22	21	18	17	—

[1] *Reported as scrapers or scraper haulers and hoists.*
[2] *Includes all haulage conveyors with a capacity over 500 ft, except main slope conveyors.*
[3] *Includes all haulage conveyors with capacity of 100 to 500 ft, except main slope conveyors.*
[4] *Not available.*

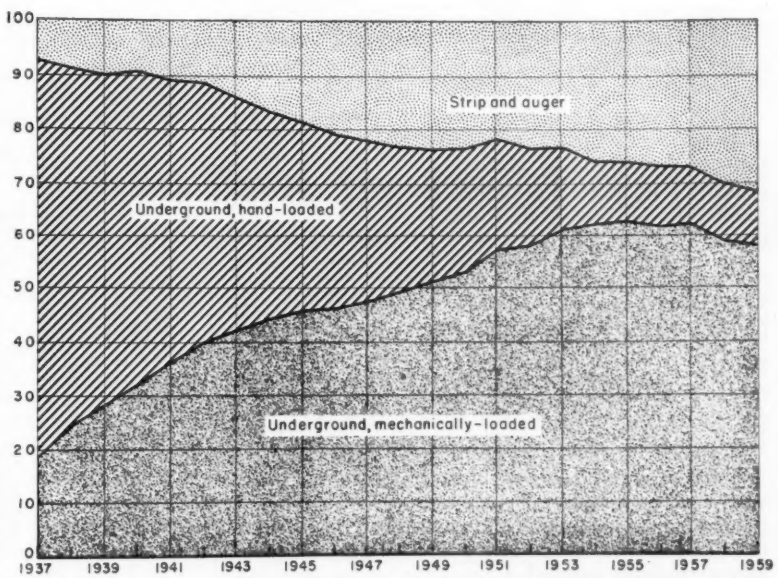


Fig. 1. Percentage of total production of bituminous coal and lignite in the United States, 1937–59, by type of mining and loading

recovery augers shipped to various states in 1959 compared with the number in use in 1958, as reported by mine operators. Sales of room conveyors as listed in table V are not exactly comparable with the number of room conveyors in use. To avoid duplication in tonnage mechanically loaded, each mine operator was instructed to report "hand-loaded" and "self-loading" conveyor tonnage only; therefore, conveyors loaded by mobile loading machines and continuous mining machines are not included with "Room conveyors in use in 1958." Shipments of coal-recovery augers to bituminous coal mines in 1959 were 14 percent of the total number in use in 1958.

TABLE IV. Sales of mechanical loading equipment in 1959 compared with machines in use in preceding years

	Number of machines in use, as reported by mine operators					Number of machines sold as reported by manufacturers in 1959
	1954	1955	1956	1957	1958	
Bituminous coal and lignite mines:						
Mobile loading machines	4,814	3,819	3,854	3,755	3,434	95
Continuous mining machines	325	385	510	614	679	140
Scrapers	48	23	35	14	7	—
Conveyors equipped with Duckbills or other self-loading heads	633	487	437	361	242	(1)
Hand-loading room conveyors, number of units	2,162	1,925	1,819	1,528	1,230	65
Anthracite mines (Pennsylvania):						
Mobile loading machines	68	79	80	66	51	2
Scrapers	359	279	303	295	290	—
Hand-loading room conveyors, number of units[2]	2,277	1,940	1,593	1,437	1,234	23

[1] *Sales of conveyors equipped with Duckbills or other self-loading heads are included with hand-loaded room conveyors.*

[2] *Includes pit-car loaders and conveyors equipped with Duckbills or other self-loading heads.*

TABLE V. Mechanical loading and mining equipment in use in 1958, by states, compared with sales reported in 1959

State	Mobile loading machines		Continuous mining machines		Scrapers		Room conveyors[1]		Coal-recovery augers	
	In use in 1958	Sales in 1959	In use in 1958	Sales in 1959	In use in 1958	Sales in 1959	In use in 1958	Sales in 1959	In use in 1958	Sales in 1959
Bituminous coal and lignite mines:										
Alabama	111	5	18	3	—	—	80	6	2	1
Alaska	2	—	—	—	—	—	—	—	—	—
Arkansas	2	—	1	1	—	—	24	—	—	—
Colorado	57	—	10	2	1	—	145	—	—	—
Illinois	144	—	38	1	—	—	10	—	3	1
Indiana	71	3	4	2	—	—	—	—	—	—
Iowa	5	—	—	—	—	—	—	—	—	—
Kentucky	501	5	38	3	—	—	50	2	82	21
Maryland	—	—	—	—	—	—	18	—	—	—
Montana, bituminous	10	—	—	—	—	—	10	—	—	—
New Mexico	2	3	—	6	—	—	1	—	—	—
Ohio	104	5	34	4	—	—	27	3	50	7
Oklahoma	5	—	—	—	—	—	78	—	—	—
Pennsylvania	661	6	303	60	—	—	419	10	38	7
Tennessee	28	—	—	—	—	—	31	1	18	2
Utah	138	—	19	3	—	—	4	—	—	—
Virginia	186	14	18	—	—	—	22	3	39	1
Washington	5	—	6	—	—	—	26	—	—	—
West Virginia	1,385	54	189	55	—	—	494	40	107	7
Wyoming	17	—	1	—	6	—	33	—	—	—
Total bituminous coal and lignite	3,434	95	679	140	7	—	1,472	65	389	47
Anthracite mines (Pennsylvania)	51	2	—	—	290	—[2]	1,234	23	(3)	—
Grand total	3,485	97	679	140	297	—	2,706	88	(3)	47

[1] *Includes hand-loaded conveyors and conveyors equipped with Duckbills or other self-loading heads.*

[2] *Also includes pit-car loaders.*

[3] *Data not available.*

Haulage Equipment

Bridge conveyors. Sales of bridge conveyors decreased five percent, from 66 in 1958 to 63 in 1959. Shipments by states are listed in table VI.

Shuttle cars. Sales of shuttle cars increased from 181 in 1958 to 233 in 1959. Details of shipments to various states in 1958 and 1959 are given in table VI. Exports of shuttle cars in 1959 amounted to approximately 14 percent of the 1959 sales in the United States.

Gathering and haulage conveyors. For the purpose of this study, "Gathering and haulage conveyors" include sectional, extensible, power-driven conveyor units that can handle over 500 ft of conveyor. Main slope conveyors are excluded. Table

TABLE VI. Units of conveying equipment sold for use in coal mines, 1958–59, by states

State	Bridge conveyors		Shuttle cars		Gathering and haulage conveyors[1]	
	1958	1959	1958	1959	1958	1959
Bituminous coal and lignite mines:						
Alabama	6	6	7	24	1	10
Alaska	—	—	—	—	—	5
Arkansas	—	1	—	—	—	—
Colorado	—	—	3	5	—	1
Illinois	—	—	4	3	5	1
Indiana	—	—	8	—	8	2
Kentucky	3	1	39	10	7	6
New Mexico	—	—	2	6	—	1
Ohio	1	1	2	8	—	—
Oklahoma	—	—	—	—	—	2
Pennsylvania	11	10	18	43	14	16
Tennessee	—	2	—	—	—	2
Utah	—	—	7	—	1	2
Virginia	1	—	24	25	18	11
West Virginia	44	40	67	109	43	59
Total bituminous coal and lignite	66	61	181	233	97	118
Anthracite mines (Pennsylvania)	—	2	—	—	—	4
Grand Total	66	63	181	233	97	122

[1] *Includes all gathering and haulage conveyors with capacity over 500 ft, except main slope conveyors.*

TABLE VII. Bituminous coal mechanically cleaned in 1958, compared with sales of mechanical cleaning equipment in 1959, by states

State	1958			Annual capacity of equipment sold in 1959 (net tons)[1]
	Number of plants in operation	Net tons of cleaned coal	Output mechanically cleaned (percent)	
Alabama	32	10,019,196	89.6	(2)
Alaska	3	323,650	42.6	——
Arkansas	(3)	(3)	(3)	——
Colorado	[4] 3	[4] 1,112,421	[4] 33.3	(2)
Illinois	61	41,440,230	94.4	1,488,000
Indiana	19	10,503,303	69.9	——
Kansas	4	753,793	91.6	——
Kentucky	79	41,065,537	61.9	2,132,000
Missouri	9	1,881,331	72.6	——
Montana	2	8,234	3.9	——
New Mexico	1	16,702	14.3	——
Ohio	24	14,651,854	45.7	——
Oklahoma	3	538,607	33.1	——
Pennsylvania	94	39,957,169	59.0	2,192,000
Tennessee	4	297,455	4.4	——
Utah	6	3,362,093	63.1	——
Virginia	30	10,566,897	39.4	(2)
Washington	5	240,094	95.2	——
West Virginia	192	82,258,768	68.9	3,685,000
Wyoming	2	37,517	2.3	——
Undistributed	—	——	——	2,128,000
Total	573	259,034,851	63.1	11,625,000

[1] *Based on average days mines were active in 1958 and 7.0 hours per day.*
[2] *Included in "Undistributed."*
[3] *Included in Colorado.*
[4] *Includes Arkansas.*

III lists sales for 1955-59, inclusive, and table VI shows shipments by states in 1958 and 1959.

Mechanical Cleaning

Reports from 21 manufacturers of bituminous coal cleaning equipment show that the total capacity of 1959 sales was 9025 net tons of clean coal per hour compared with 10,350 tons of capacity sold in 1958, a decrease of 13 percent. Sales in 1959, by type of equipment, in terms of capacity, show that jigs ranked first, followed by dense medium and wet tables. The capacity of all types of equipment sold in 1959 for cleaning bituminous coal was equivalent to five percent of the bituminous coal cleaned in 1958. Approximately 64 percent of the total capacity of cleaning equipment sold in 1959 was for additions or replacements to present installations and the remaining 36 percent was for new plants.

Table VII gives data on bituminous coal cleaned in 1958, and the annual capacity of equipment sold in 1959, by states.

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Roof Falls—

*The Supervisor's Responsibility**

SAFETY is everybody's responsibility, the mine workers' as well as the supervisors'. Living up to the responsibility often is not easy. It sometimes requires considerable effort to maintain high standards of safety, and often both mine workers and supervisors become lax in their safety efforts. But, since it is the *duty* of supervisors to be the *leaders* in accident prevention, it is up to them to set the example by being more safety conscious than anyone else in a mine.

The supervisor's safety role is unmistakably important where roof fall accidents are concerned. A survey of roof fall accidents over a three-year period by the U. S. Bureau of Mines indicated that from 32 to 50 percent of the fatalities occurred because of supervisors' failure to carry out their responsibilities. A concise breakdown of the survey's data indicated the following:

Responsibility for Roof Fall Accidents	*Percent*
Supervisory and management failure	**32 to 50**
Employe failure	**23 to 33**
Joint or undetermined human failure	**7 to 24**
TOTAL HUMAN FAILURE	**80 to 88**

It is obvious that each supervisor has a great part to play in mine safety. His sincerity in accident prevention, combined with a working knowledge of the fundamentals of accident prevention, can bring about a safer mine. Thus, the control of roof fall accidents can be directly charged, to a great extent, to his performance.

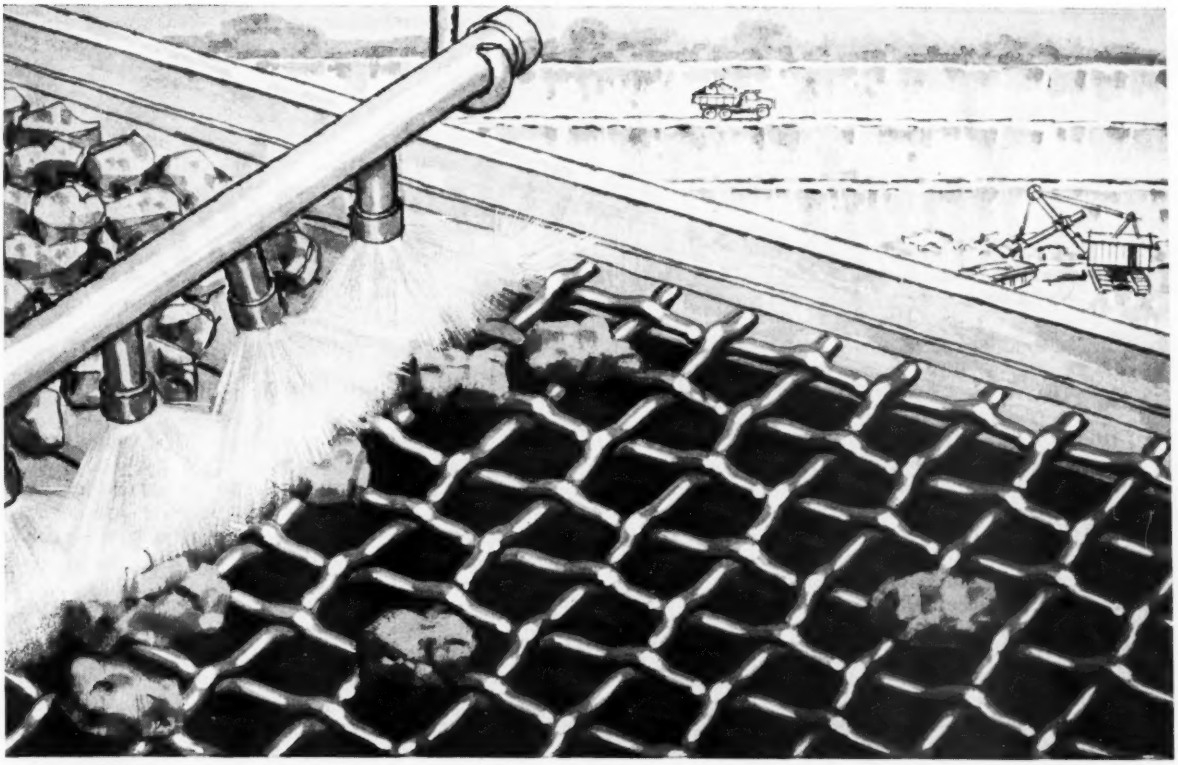
How, then, must the supervisor go about the job of reducing roof fall accidents? There is no doubt that he is expected to appreciate the full value of accident prevention and maintain his active interest in it, even though some of his workmen show lack of concern. He must realize that if he hopes to maintain a high point in his operating efficiency, he must accept accident prevention as an integral part of his day-to-day activities.

The following are a few fundamental thoughts as to how supervisors can prevent accidents. To start with, a supervisor must:

1. **Be a Salesman. Even with the best equipment, mining plans, and techniques, people must be persuaded. This can be done best by the supervisor who is himself convinced, and who can effectively convince others.**
2. **Know the Subject. No salesman can sell his product if he doesn't understand it. He must know the contributing factors in roof fall accidents well enough to discuss them thoroughly with his men.**
3. **Know the Potentials of Accidents. Each supervisor should study and know the causes of roof fall accidents as they apply to areas under his care. All mines and all sections are not the same. He should know his own problems and the manner in which they can be best handled and controlled.**
4. **Talk with His Employes. It is basic that he be able to converse with his employes. By understanding his men, he can learn and profit from their knowledge and experience. This can only come from talking with his employes.**

Summing up, a supervisor can be successful in the prevention of roof fall accidents if he believes, and keeps sharply aware—that these accidents are mostly man-made and can be prevented—that prevention of roof fall accidents is essential to his development and success as a supervisor—that his ability to sell safety programs to his men is a prime requirement of his job—that confidence in his own ability, and thus improved results, can be obtained through his interest in and enthusiasm for safety—and, lastly, that the best cost and production performances can be attained by a program that stresses: *Safe Workmen Make Better Coal Mines!*

* *Prepared by the Advisory Committee 1960 National Campaign to Prevent Injuries from Roof Falls in Coal Mines.*



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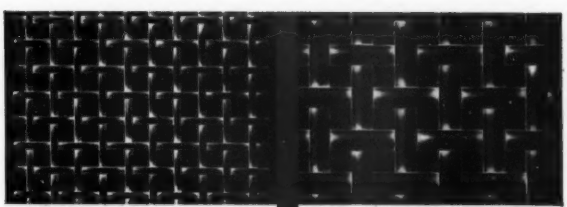

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7565

As Viewed by HENRY I. DWORSHAK of the American Mining Congress

PRESIDENT EISENHOWER, in his annual Economic Report to Congress January 20, predicted that the present high level of economic activity would continue through the balance of 1960 and "with appropriate private actions and public policies, it can carry well beyond the present year." Amplifying his views on "appropriate" public policies, he called once again for sound fiscal policies and the adoption by Congress of his recommendation to lift the ceiling on Government securities interest rates.

In a letter transmitting the report to Congress, the President noted that production and income set new records in 1959 despite the handicap of the 116-day steel strike. He said the Gross National Product hit an annual rate of $482 billion in the fourth quarter of 1959 and, when adjusted for price changes, this rate was 3.5 percent higher than the rate attained in the corresponding period of 1958. The President cautioned against "speculative excesses and actions that would compress gains into so short a period that the rate of growth could not be sustained."

He added: "We must seek, through both private actions and public policies, to minimize and contain inflationary pressures that could undermine the basis for a high, continuing rate of growth."

1961 FEDERAL BUDGET SURPLUS FORESEEN

In his annual budget message to Congress, President Eisenhower recommended Federal expenditures totaling $79.8 billion during the 1961 fiscal year, which will begin next July 1. He estimated receipts at $84 billion, with a resulting surplus of $4.2 billion. These figures compare with an estimated surplus of $200 million for the current fiscal year, based on expenditures of $78.4 billion and receipts of $78.6 billion.

★ ★ ★ ★ ★ ★

Washington Highlights

FEDERAL BUDGET: 1961 surplus foreseen

COAL RESEARCH: Subcommittee approves bill

LEAD-ZINC: Tariff Commission holds hearings

MINING AID: President's views sought by Committee

LABOR LAWS: Special study asked

MINING MACHINERY: Sales increase predicted

★ ★ ★ ★ ★ ★

The budget clearly showed that the surplus is based upon anticipation of a booming economy's bringing in additional revenues under existing laws, plus legislation to extend the corporate and excise tax rates scheduled for expiration or reduction next June 30 and to increase postal rates.

President Eisenhower recommended that the surplus be used to reduce the public debt to $280 billion. "In my judgment this is the only sound course," he said. "Unless some amounts are applied to the reduction of debt in prosperous periods, we can expect an ever larger public debt if future emergencies or recessions again produce deficits.

"In times of prosperity, such as we anticipate in the coming year, sound fiscal policy requires a budget surplus to help counteract inflationary pressures, to ease conditions in capital and credit markets, and to increase the supply of savings available for the productive investment so essential to continued economic growth."

COMMITTEE APPROVES COAL RESEARCH BILL

A compromise bill to authorize expanded Government activity in the field of coal research was approved last month by the House Interior Committee after Secretary of the Interior Fred Seaton furnished assurances that he would press for an immediate appropriation to implement the program.

The new measure is similar in many respects to a bill pocket-vetoed last fall by the President. At a hearing January 18, Assistant Interior Secretary Royce A. Hardy said that enactment of the legislation would permit the Secretary of the Interior to establish an Office of Coal Research within the Department empowered to (1) plan a comprehensive coal research program; (2) coordinate private and Governmental research projects; (3) develop, in conjunction with advisory committees, specific projects to recommend directly to the Secretary; and (4) negotiate contracts, subject to the Secretary's approval, with industry associations, educational institutions, and appropriate State agencies for coal research.

"It is recognized," Hardy said, "that there is a need for the shorter range type of coal research which will point the way to development of mining methods and equipment, as well as to ways of improving efficiency and thereby increasing the utilization of this abundant resource.

"It is our belief, generally speaking, that the short-range research projects can best be accomplished by the arrangements with such institutions," Hardy declared, adding that

the Bureau of Mines would continue to conduct longer range research projects.

Julian Conover, executive vice president of the American Mining Congress, told the Subcommittee that "Coal companies individually and in concert do, to the extent of their resources, finance a considerable amount of research which gives promise of yielding benefits within a reasonable time, but an expanded research program, requiring Government support, is needed." He added, "In our coal reserves, this nation has its greatest hydrocarbon energy asset. It is in the interest of everyone that this asset be developed and used efficiently and wisely . . ."

The measure, which would authorize a $2 million appropriation for the first year's operations, was also endorsed by Joseph E. Moody, president of the National Coal Policy Conference, and Stephen F. Dunn, president of the National Coal Association.

TARIFF COMMISSION STUDIES LEAD-ZINC PROBLEMS

As part of a general lead-zinc investigation it is currently conducting at the direction of the U. S. Senate, the Tariff Commission last month held five days of hearings during which nearly 40 witnesses appeared.

Kicking off the hearings were eight members of Congress, who stated that the domestic lead-zinc mining industry continues to suffer injury and that further curbs on imports are necessary. They were Senators Murray (Dem., Mont.), Dworshak (Rep., Idaho), Bennett (Rep., Utah), Moss (Dem., Utah), Wiley (Rep., Wis), and Kerr (Dem., Okla.), and Reps. Edmondson (Dem., Okla.), Hargis (Dem., Kan.), and Pfost (Dem., Idaho).

First industry witness was Miles P. Romney, chairman of the Emergency Lead-Zinc Committee, who spearheaded the testimony of seven other spokesmen for his Committee. They presented detailed statements to show that, during the first full year of import quotas, which ended September 30, the domestic lead-mining situation had worsened and zinc mining had benefited only slightly.

In concluding his Committee's presentation, Romney noted that the Administration's co-called Seaton plan—defeated by the House in 1958 although it had earlier won Senate approval—was aimed at stabilizing annual domestic mine production of lead at 350,000 tons and of zinc at 550,000 tons, with returns to the producers being keyed to prices of 15½ cents per pound for lead and 13½ cents per pound for zinc. A later canvass of domestic producers, Romney said, confirmed that these prices are the minimum necessary to attain these production targets.

Romney declared that the industry's problem "must be resolved on a permanent basis and that this can best be done through legislation." Stating that his Committee has consistently preferred import taxes as the method of controlling excessive imports, he endorsed legislation pending in both Houses of Congress that would impose an import tax of 4 cents per pound on lead and zinc metal and 2.8 cents per pound on the metal content of ores and concentrates—with the taxes suspended when the domestic prices for lead or zinc are at least 15½ cents and 13½ cents per pound, respectively. The legislation would also impose import taxes on a wide range of lead and zinc manufactured articles in addition to any present duties, but the additional duties would be suspended when the import taxes on unmanufactured lead and zinc are not in effect.

Romney said that this legislation—if amended in certain respects with regard to the on-and-off provisions—would assure a reasonably healthy and economically sound domestic mining industry.

He also recommended that the Commission give serious consideration to a flexible import quota plan embodied in pending House legislation. This plan would involve absolute quotas until the domestic price of lead or zinc exceeds 15½ cents or 13½ cents, respectively at which time permissible imports would be adjusted to the difference between U. S. consumption and U. S. mine production. Compensatory import controls would also be established on a variety of manufactured products of lead and zinc.

Richard A. Young, vice president of American Zinc, Lead & Smelting Co., told the Commission that quotas, when considered superficially, sound "ideally suited to take care of the entire situation," but further study makes it "equally obvious that there are many problems raised."

Young said he favored a permanent specific duty as the type of protection most ideally suited to the zinc industry. "It is quick in its effect and is effective in accomplishing its purpose under all but the most unusual conditions," he added.

When questioned as to what he considered an adequate rate of duty on zinc metal, Young suggested 2.1 cents per pound. This rate, he said, should result in a fair price of 12 to 14 cents per pound for zinc.

Robert P. Koenig, president of Cerro de Pasco Corp., said the lead-zinc quota system has not really benefited anyone "except perhaps the large-scale efficient domestic miners who have enjoyed some windfall profits. . . . These quotas are exactly the kind of destructive response which the United States should not take in its attack on its balance of payments deficit problem. . . ."

Simon D. Strauss, vice president of American Smelting & Refining Co., testified that continuation of the quota system, regardless of effects on prices or production, "is a very serious threat to the long-term future of the lead-zinc industry." He also declared that any increase in tariffs must be carefully considered because of the industry's volatile nature.

Strauss forecast that free-world lead consumption will catch up with production very soon, a situation which he said already exists in the case of zinc. As a result, he added, quotas may induce an artificial shortage and encourage substitution.

He said tariffs are a better remedy than quotas, but only as an alternative if the Commission finds continued protection of the domestic mining industry is necessary. Any tariff increases, he declared, should not go higher than the 1930 level—2⅛ cents per pound on lead and 1¾ cents per pound on zinc.

John J. Lennon of Amco Division, American Metal Climax, Inc., said no additional import restrictions are needed. "On the contrary, a relaxation of the existing import restrictions on lead and zinc would be more conducive to the maintenance of a sound and stable lead and zinc industry, including mining, and would at the same time be more in harmony with the public interest," he declared. Continuation of the quotas, he added, will force lead and zinc prices to a point at which substitute products would take over parts of the market. He also said his company would prefer no increase in tariffs.

Smelter spokesmen opposed to continuation of the quotas included Frederick R. Jeffrey of National Zinc Co. He recommended, in lieu of quotas, a slab zinc import duty of 2½ cents per pound, stating that "I cannot quite see a tariff such as 4 cents with a [zinc] price that is already heading for 13½ cents."

With the exception of two domestic labor union representatives, other witnesses—including spokesmen for

Mexican and Canadian interests—were generally opposed to any type of import restrictions.

PRESIDENTIAL REPLY TO MINING RESOLUTION SOUGHT

Last summer Congress adopted a concurrent resolution requesting the President to review present Government minerals policies and report promptly to Congress any steps he finds necessary to aid depressed segments of the mining industry, including the submission of any reorganization plans or legislation that might be appropriate. A resolution of this type does not have the force of law; it merely expresses the intent of Congress.

The resolution, introduced by Chairman Aspinall (Dem., Colo.) of the House Interior Committee, also asked that existing programs of Government agencies be reviewed at once with a view to using them more effectively to restore employment and production in critically depressed mining industries.

In a recent letter to President Eisenhower, Chairman Aspinall pointed out that a December 5 letter from the White House was concerned with lead and zinc only and "did not touch upon the general problems of the domestic mining and mineral industries" referred to in the resolution.

"Having in mind the national scope and the emergency nature of the problems involved, Aspinall wrote the President, "I am sure that close attention is being given to these matters within your office and the Departments concerned. In view of the prospective schedule of the present Congress, requiring that all actions be handled promptly, I should appreciate having at this time an indication of the progress made in, and any conclusions now available from, the reviews and studies requested by the resolution."

LABOR LAW STUDY ASKED

Senator Goldwater (Rep., Ariz.) has asked the Senate to set up a temporary special committee to conduct an investigation of "the impact of labor-management disputes and of collective bargaining generally" on the national economy and on the well-being of the American public, and to determine whether any changes in Federal laws are required in order to protect the national economy and to safeguard the interests of the public.

The eight-member committee would consist of four Senators from the Inter-state Commerce Committee and four from the Labor and Public

(*Continued on page 140*)

Ruggles-Coles

ROTARY COOLERS IN FOUR TYPES

GAS-COOLED TYPE—Solids are cooled by direct contact with cooling air (atmospheric, or dried and refrigerated). Inert gases may be used in a closed system.

WATER-COOLED SHELL—Water is externally applied to the shell, either by sprays or by partially submerging the shell.

TUBULAR TYPE—Internal water-cooling tubes are assembled with the rotating shell, or installed as a stationary bank of tubes concentric with the shell. Alternately, the water leaving either of these tube sections may be used for supplemental spray cooling on the shell exterior.

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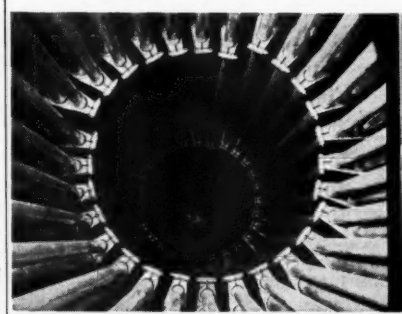
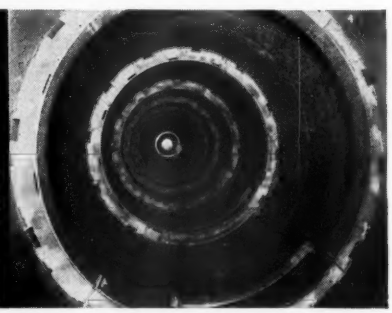
Each of these types has a particular area in which it is most economically applied. Write for further information.



Interior of a water-tube cooler. Longitudinal banks of tubes provide maximum cooling surface for minimum floor space.



Interior of partially-submerged cooler with gravity-controlled scrapers maintaining clean shell surface for high-rate heat transfer.

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personals

Russel B. Caples, vice president of the Anaconda Co. since 1958, recently retired but will act as a consultant to the company. Caples' career with Anaconda began in 1910 in the testing and research department. He held various supervisory positions from 1915 to 1941, when he became manager, Great Falls Reduction Department. In 1953, he was elected president of Anaconda Alumi-

R. Caples

W. Wraith, Jr.

T. Graham

num and two years later was named vice president in charge of metallurgical operations of all the company's properties.

The company also announced that **William Wraith, Jr.,** has been elected an assistant vice president. Formerly metallurgical manager, he will continue to direct and supervise the metallurgical operations of the company and its subsidiaries. Wraith joined Anaconda in 1926.

At the same time **Thomas K. Graham** was advanced to the position of metallurgical manager. His association with Anaconda began in 1935 in the research department. In 1956 he became manager of the Raritan Copper Works, International Smelting & Refining Co., a wholly-owned Anaconda subsidiary. He rejoined the parent company in 1958 as assistant metallurgical manager.

Other changes within the company include a reorganization of the metallurgical research department into three major departments. **Robert E. Sullivan** has become assistant director of metallurgical research in charge of chemical research; **Theodore G. Fulmor,** assistant director of metallurgical research in charge of concentration; and **W. Harold Foard,** assistant director of metallurgical research in charge of pyrometallurgical research.

Berwind-White Coal Mining Co. has announced the election of **Edward J. Behn** to the company board of directors. He is assistant to the president. At the same time **Robert P. Koenig,** president of Cerro de Pasco Corp., and **Leslie M. Cassidy,** former chairman of Johns-Mansville Corp., were also elected to membership on the board. Behn, Koenig and Cassidy were further elected to the board of directors of New River and Pocahontas Consolidated Coal Co., an operating affiliate of Berwind-White in West Virginia.

Christian F. Beukema has been appointed president of Oliver Iron Mining Division of U. S. Steel Corp. succeeding the late Rudolph T. Elstad. Beukema began his career with U. S. Steel in maintenance and construction engineering at Michigan Limestone Division, Rogers City, Mich. Following World War II service, where he attained the rank of Major, he returned to the Rogers City operation and later served in U. S. Steel's Pittsburgh offices. In 1953 he was named general manager of operations for the Michigan Limestone Division, becoming vice president in 1954. Until the recent appointment, he had been president of the limestone division since 1955.

J. E. Stewart has become general sales manager, Pennsylvania Division, Consolidated Coal Co. He has been associated with Consolidation Coal for 20 years.

Richard J. Hefler, vice president-finance, American Potash & Chemical Corp., has been elected a director succeeding the late William J. Hutchinson. Hefler joined American Potash in 1948 and became a vice president in 1957.

R. E. Salvati, president of Island Creek Coal Co., has been elected a director of the Norfolk & Western Railway, one of the nation's leading coal carriers.

Oscar A. Glaeser was recently elected president of Utah Mining Association. He is vice president and general manager of Western operations, United States Smelting, Refining & Mining Co. At the same time **S. K. Droubay,** vice president and general manager, United Park City Mines Co. was elected first vice president; **F. C. Green,** general manager, Utah Copper Div., Kennecott Copper Corp., second vice president, and **Mitchell Melich,** president, Uranium Reduction Co., third vice president. **Miles P. Romney** and **Walter M. Horne** were re-elected to the respective offices of secretary-manager and assistant secretary-manager.

O. A. Glaeser

John W. Scales of the Enos Coal Sales Division, Pickands Mather & Co., was recently elected president of the Indiana Coal Association.

Other officers include **John L. Barnett,** Blackfoot Coal & Land Corp., vice president; **L. E. Sawyer,** re-elected secretary-treasurer, and **David Ingle, Jr.,** Ingle Coal Corp., **H. P. Smith,** Preston Mining Co., **William G. Stockton,** Viking Coal Corp., **L. B. Girard,** Peabody Coal Co., and **Roy E. Dean,** Ayrshire Collieries Corp., directors.

Hugh J. Leach was recently elected vice president—foreign operations and iron ore development, Cleveland-Cliffs Iron Co.

Leach will be succeeded, as manager of Michigan Mines, by **Harry C. Swanson,** who has been general superintendent of the company's iron ore mines in Michigan.

John P. Hicks has been appointed sales manager of Lehigh-Boone Bituminous Corp. Secretary and a director of the company since 1958, he will retain his previous duties.

Richard F. Goodwin has joined Cerro de Pasco Corp. as a mining consultant. He will initially devote his efforts exclusively to the company's Rio Blanco project in Chile.

Recent personnel changes have been announced at American Zinc Company of Tennessee, Mascot, Tenn. **D. B. Grove** retired as superintendent, milling department, after 47 years of continuous service. Grove was succeeded by **James H. Polhemus** formerly asistant milling superintendent, who has been with the company 17 years. **James P. Snider,** metallurgist, was named assistant milling superintendent.

Jean Vuillequez has been elected president, chairman of the board of directors and chairman of the executive committee of the Lead Industries Association. A director of the association since 1953, he is a vice president, a director and member of the executive committee, American Metal Climax, Inc.

R. W. Stensrud, Erie Mining Co., has been appointed plant engineer at the company's Hoyt Lakes taconite operations. He replaces **W. N. Thomas** who recently became chief mechanical engineer, Pickands Mather & Co.

David P. Shirra has been elected vice president of Western Gold & Uranium, Inc. A director of the company since 1949, he had retired from a vice presidency in 1957. His return follows the death of Ralph G. Brown, chairman of the board, who died December 31. The company also announced the election of **Richard W. Ince** as chairman and **Melvin A. Conant** and **Stanley Brown** as directors. Western Gold operates the Orphan uranium mine near Grand Canyon, Ariz.

C. E. Mattox, purchasing agent for Peabody Coal Co., retired January 1 following 32 years of service with the Peabody-Sinclair-Kelce organizations.

W. P. Pan, assistant chief mining engineer for Oliver Iron Mining Division, Western district, Mesabi iron range, U. S. Steel Corp., has retired after 40 years' service with the Oliver Division.

John W. Hall has been elected president of Potash Company of America succeeding **F. O. Davis,** who is retiring but will continue to serve the company as a consultant. Hall, who has been vice president-sales for the last four years, has been associated with PCA for ten years.

H. L. Roscoe, president of Normetal Mining Corp., Ltd., and Quemont Mining Corp., Ltd., has retired. He was succeeded by **J. A. H. Paterson,** general manager of the Mining Corporation of Canada, Ltd., which controls both companies. Roscoe will continue as a director of Normetal and Quemont.

E. K. Barnes has been re-elected president of the Northwest Mining Association. **Ross D. Liesk,** consulting mining engineer was renamed a vice president and **Malcolm Brown,** president, Sidney Mining Co. was elected to the other vice president post. **Frank Marr** continues as treasurer and **Robert J. Towne** was named secretary.

Harry F. Haller recently became superintendent of the Church Rock mine, Phillips Petroleum Co.

A. E. Petermann has been named president of Alabama Metallurgical Corp., succeeding **Lester G. White** who recently resigned for reasons of health. Petermann, vice president and general counsel for Calumet & Hecla, Inc., will continue with that company.

Frank B. Jewett, Jr., has been elected president of Vitro Corporation of America. He succeeds **J. Carlton Ward, Jr.,** who became chairman of the board of directors. **Charles S. Payson,** retiring board chairman, was elected to the new office of chairman of the executive committee.

James A. Briggs, general superintendent, New Cornelia Branch, Phelps Dodge Corp., has been promoted to manager succeeding **Alfred T. Barr** who is retiring. Barr had been manager since 1953 and had been employed at the Ajo operation for 38 years.

Lawrence A. Roe has been appointed to the new position of staff director, minerals processing, for International Minerals & Chemicals Corp. He had been director of development in the Research, Engineering and Development Division. In the new post, he will be responsible for coordinating mineral processing methods within the company and for reporting on new processing techniques in the industry. **Raymond E. Tuttle** succeeds Roe as director of development.

OBITUARIES

Fred P. Diener, 61, director of research, Universal Atlas Cement Division of U. S. Steel Corp., died January 12 in Eastchester, N. Y.

During his 36-year association with Universal Atlas, Mr. Diener earned recognition as a major factor in the continuous program of the division's test and research activities for the betterment of existing cement products and the development of new ones. In the cement industry, he was considered one of the top authorities on the technology of cement and concrete uses.

Joseph Gladstone Calverley, died at Pittsburgh, December 26.

Mr. Calverley had been a field engineer for the U. S. Bureau of Mines and National Recovery Administration, and helped form and operate Union Collieries Co. He retired in 1954, at which time he was associated with Wieman & Ward Co.

Walter L. Penick died November 10 at San Francisco. He had been manager of the San Francisco office, Western Precipitation Division of Joy Manufacturing Co. for 23 years.

Holland Russell Wemple, 67, retired vice president and director of Texas Gulf Sulphur Co., died December 27 at Springfield, Ill.

George Wingfield, 83, died in Reno, Nev., December 25.

Mr. Wingfield, in association with the late Senator George Nixon, organized Goldfield Consolidated Mines Co. in 1906, which became one of the nation's most important gold producers. He headed many successful mining ventures in Nevada and had been president of Getchell Mine, Inc., an association with that company that began when he helped organize it in 1936. In addition to his mining interests, Mr. Wingfield had been an important figure in Nevada banking, business, and politics for nearly 40 years.

Unshot Rocky Digging

This Marion 151-M works a 35-40 foot bank of unshot, rocky digging on the Iron Range. Its ability to produce low unit costs under difficult digging conditions has made the 151-M a familiar sight in open pit mines across the nation. Why not let a Marion mining specialist project 151-M unit costs on your property? For years, Marion has been recognized for recommending the right methods and the right machines to produce needed tonnage at the lowest possible costs.

CONSULT MARION MINING SPECIALISTS
for lowest costs on your property!

MARION POWER SHOVEL COMPANY • Marion, Ohio, U.S.A.

A Division of Universal Marion Corporation

WANT FASTER FOOTAGE?

Step lively with Gardner-Denver air leg drills

QUALITY EQUIPMENT PLUS!

Why specify Gardner-Denver? You get more than a quality product! Skilled Gardner-Denver mining equipment specialists are always available to lend any assistance needed to insure the equipment you use is right for the job. At Gardner-Denver *there's no substitute for men*—our 100-year philosophy of growth.

Easy to use—drilling controls all grouped on back head for convenient operation.

Easy to move—lightweight aluminum alloy feed cylinder keeps drill weight down, production up . . . makes setup and moving easier.

Push-button bleed—located on "D" handle—releases air pressure in feed leg fast.

Built-in safety—exclusive, air-operated water gland automatically provides "water on, air on . . . air off, water off" drilling cycle.

Stays clean inside—constant air blowing through chuck end keeps water and cuttings from entering drill.

Hard-hitting drills—your choice of fast-acting 2½" or 2⅝" drills. Feed travels of 24", 36", 48" or 60".

Leave the leg work to Gardner-Denver air leg drills . . . see your Gardner-Denver mining specialist soon.

GARDNER-DENVER Since 1859

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

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Export Division, 233 Broadway, New York 7, New York
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

Pittsburgh Getting Ready For

1960 AMC COAL CONVENTION

COME next May 9–11 Pittsburgh's Golden Triangle will really be buzzing as coal mining men and manufacturers of mining equipment, along with their wives, descend upon the "World's Coal Capital" for the 1960 Coal Convention of the American Mining Congress. This will be the first return of the AMC Coal Convention to Pittsburgh since 1933 and it's difficult to say which has changed more in the intervening period—coal mining or Pittsburgh. The city, which is generally considered the foremost example of what can be done in smoke abatement and urban redevelopment, is a natural choice for this year's largest industry meeting. Expanded hotel facilities assure ample accommodations for those attending, and the proximity to major coal producing areas will mean added attendance and increased interest.

The National Program Committee, under the Chairmanship of R. H. Hughes, President, Clinchfield Coal Co., has come up with an outstanding array of speakers. An advance program was recently distributed throughout the industry and the March issue of *Mining Congress Journal* will carry a preliminary program outlining the topics to be covered by each presentation. Of special interest will be the opening session at which representatives of the Congress of the United States, the Atomic Energy Commission, the Tennessee Valley Authority and other Government agencies having to do with coal will discuss various facets of a National Fuels Policy.

Other highlights of the week will be a Welcoming Luncheon on Monday, at which a leading representative of the Administration will speak, and a special luncheon Tuesday to be addressed by Richard Harkness, widely-known NBC news commentator and analyst.

The technical sessions, as always, will feature recognized industry leaders discussing the most recent advances in all phases of the art of mining and preparing coal.

An all-day Tax Forum of special interest to accountants and others handling tax matters will be held Wednesday. It will be devoted to a discussion of current tax problems of the coal industry—with ample opportunity for discussion.

On the lighter side, two gala affairs for mining men and their ladies have been arranged. The Annual Coal Miners Party, emphasizing fun, food and frolic, will be held Monday evening at the Pittsburgh-Hilton Hotel. Wednesday evening, the traditional "speechless" banquet will feature brief introductions of honor guests and a spine-tingling variety show, as well as a superb dinner.

Mining ladies have not been forgotten in all the advance planning, either. A Ladies Committee, with Mrs. James C. Gray as Chairman and Mrs. Jesse F. Core and Mrs. Harry F. Lawrence as Vice Chairmen, has arranged two special functions, which, along with the Welcoming Luncheon, the Coal Miners Party, the Banquet and their shopping, will keep the ladies fully occupied. Tuesday a tour of Pittsburgh's points of interest will be made—including a ride on an incline, a visit to the Nationality Rooms at the University of Pittsburgh and a look at the Stephen Foster Memorial—culminating in a buffet luncheon at the beautiful Longue Vue Country Club, high above the blue waters of the Allegheny River. Wednesday our newest State will be honored at a Hawaiian Luncheon which will feature a showing of Hawaiian fashions adapted to mainland wear.

An innovation at AMC Coal Conventions will be two trips Thursday, May 12, of special interest to coal mining men. One group will visit the strip mining operations of Hanna Coal Co. in eastern Ohio to see the Georgetown preparation plant, the initial pumping station of the famous coal pipeline, and to inspect the "Mountaineer"—the first of the 75-yd class of stripping shovels. Another party will visit the Maple Creek preparation plant of U. S. Steel Corp., one of the newest plants of its kind in the world. The plant utilizes dense medium, double-deck tables and a special circuit to clean the extreme fines, and incorporates many recent developments in coal preparation.

Now is the time to complete plans to attend the 1960 Coal Convention of the American Mining Congress. If you haven't already done so, write the AMC Housing Bureau, Pittsburgh Convention Bureau, 411 Seventh Ave., Pittsburgh 19, Pa., for hotel accommodations. There is no headquarters hotel, and official functions will be divided between the Penn-Sheraton and the Pittsburgh-Hilton, so you will be close to the center of activities wherever you stay.

NEWS and views

Penn State Inaugurates New Training Program

A student-trainee program to supplement the regular four-year curriculum in mining engineering has been inaugurated by the Department of Mining, Pennsylvania State University. The new plan has resulted from concern about the shortage of engineers entering the mining industry in contrast to demand.

The program will go into effect in July and is designed specifically to benefit companies in the mineral industries by providing a steady supply of technical personnel. Students enrolling in the program will attend school six months, then work in industry six months, over a four-year period. They will remain in school continuously the fifth year. The curriculum to be followed will be identical with the present one but will be rearranged to permit the student to obtain his bachelor of science degree in five years.

Participating companies will provide employment to students for alternating periods as engineering trainees. Students entering the program will be selected by either the University, through the Department of Mining, or by cooperating companies, but they must meet University entrance requirements and maintain satisfactory grades to remain in the program.

Cleveland-Cliffs to Expand

Cleveland-Cliffs Iron Co. is planning to boost its annual production of iron ore in the next ten years to 16,000,000 gross tons from the present 9,000,000. The expansion is scheduled to keep abreast of an anticipated increase in national annual steel ingot production capacity to 150,000,000 tons at an 80 percent operating rate by 1965.

Humboldt Mining Co., jointly owned by Cleveland-Cliffs and Ford Motor Co., has also announced that it will expand its iron ore mining and concentrating operations near Ishpeming, Mich., by installing two parallel lines of Allis-Chalmers Grate-Kiln systems to agglomerate flotation concentrates. Production of specular hematite from Humboldt's open pit mine and concentrator is presently 1000 long tons per day of concentrate. This will be doubled. The facility is scheduled to begin producing iron ore pellets around mid-1960.

Appalachian Power Buys 18,000,000 Tons of Coal

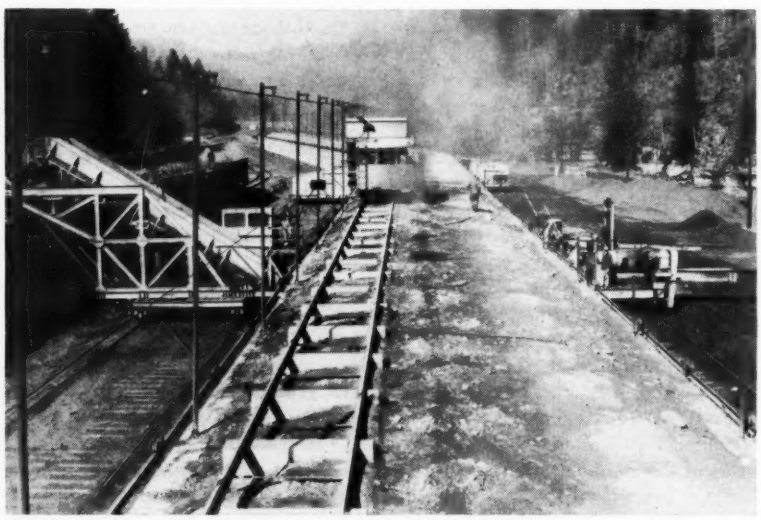
Clinchfield Coal Co. has contracted to deliver 18,000,000 tons of coal over a 30-year period to the Appalachian Power Co., a subsidiary of American Electric Power, for use at its Russell County, Va., electric generating plant.

Appalachian announced plans for a third 226,000-kw generating unit costing $28,000,000 to be built in the next two years at its Clinch River plant at Carbo. The two initial units were put into service late in 1958. Clinchfield, a division of the Pittston Co., now supplies the plant with 1,200,000 tons of coal each year. The additional unit, which will require the added coal, is expected to be finished by late 1961. The additional coal will be supplied by the new Moss No. 3 mine, which is only a few miles from the generating plant.

Sulphur Manual

Texas Gulf Sulphur Co., Inc., 75 East 45th Street, New York 17, N. Y., recently issued a comprehensive, detailed *Sulphur Manual* that will be not only interesting but beneficial to

(*Continued on opposite page*)



SPECIAL HANDLING EQUIPMENT for charging and pushing coke ovens at the rate of one every 3.6 minutes has been placed in operation at a new coking plant near Big Stone Gap, Va., by Connellsville Manufacturing & Mine Supply Co. The equipment is servicing 180 Mitchell beehive coke ovens of Stonega Coke & Coal Co. at its Pine Branch colliery near the Virginia-Kentucky stateline. Completely mechanized, the ovens are designed to produce some 650 tons of low ash, low sulphur metallurgical coke daily

(*Continued from previous page*)

companies now using or planning to use solid or molten sulphur.

The manual is divided into four sections, followed by an appendix, with the following contents:

Section I. Entitled "The Sulphur Industry," it provides an up-to-date comprehensive discussion of the sulphur industry on a world-wide basis.

Section II. "Shipping of Molten Sulphur" details Texas Gulf's own experience with molten sulphur and recommends certain procedures.

Section III. Instructions on how to take care of molten sulphur shipments when they come in and how to set up both central and subsidiary storage facilities are given in "Handling and Storage of Molten Sulphur."

Section IV. "Analysis of Sulphur" details the latest analytical methods for checking the purity of sulphur, the best methods of sampling both solid and molten sulphur, and the most satisfactory analytical apparatus to use.

Appendix A. This part, entitled "Physio-Chemical Properties of Sulphur," comprises a review of all the properties of sulphur, with the latest proved determinations.

Manual purposely has an over-size binder as the company is already working on additional sections which will be sent to those having copies of the manual.

On request, the company will be glad to send the manual and/or individual sections.

Another Copper Ore Body Discovered at White Pine, Mich.

Geological exploration studies of Copper Range Co. have indicated a substantial copper orebody a short distance west of White Pine in northern Michigan. The exploration was conducted on previously unexplored mineral holdings of White Pine Copper Co., a wholly-owned subsidiary of Copper Range and operator of a large underground low-grade copper mine at White Pine. Copper Range consultants and the White Pine staff are planning to supplement the diamond drilling program by sinking an exploratory shaft.

Medusa Announces Multimillion Dollar Expansion

Portland Cement Co. has announced a $9,000,000 expenditure for additional production capacity, limestone lands, and product quality improvements as the first step in a $70,000,000 ten-year expansion and modernization program.

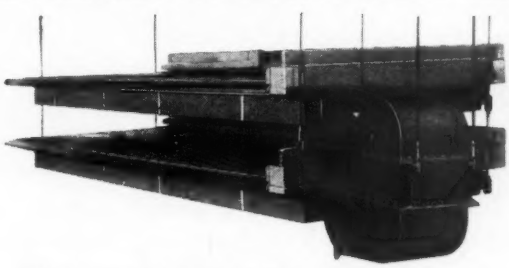
A major part of the expansion is a 1,000,000-bbl addition to its Dixon, Ill., cement plant. The new kiln there is scheduled to go on stream in the spring of 1961. Other important installations are planned for the York, Pa., and Toledo, Ohio, plants and its Wisconsin subsidiary, Manitowoc Portland Cement Co.

Medusa is also in the process of exercising options on limestone properties in southern Illinois and southeastern Pennsylvania, both of which the company regards as potential new cement plant sites.

Major Copper Producers Form Development Association

Six major copper producers have joined together to form the Copper Products Development Association. To be primarily a research organiza-

(*Continued next page*)



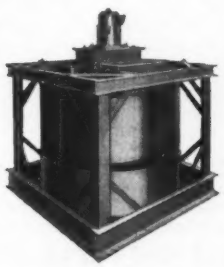
The CONCENCO® "77" Table Permits You to Build Smaller Coal Washing Plants

The revolutionary "77" table with its twin decks is not only able to double the feed capacity in a unit of floor space, but it halves the laundering, piping, wiring and connected power requirements.

You are thus able to build more compact and less costly structures for your fine coal cleaning operations. And because the "77" is in floating suspension, with impact to the building virtually eliminated, lighter construction is permissible to effect further economy.

Cleaning efficiency is in the same high range for which the single deck SuperDuty® table has long been famous.

For complete information, send for Bulletin 77.



CONCENCO® Feed Distributor

While unexcelled for feeding coal washing tables, the CONCENCO Feed Distributor effectively provides an accurate splitting of feed into any desired number and proportion of parts to feed circuits or machines in battery for their greater overall efficiency. It is a heavily fabricated all steel machine with motor drive requiring 1 h.p. or less in operation.

THE DEISTER ★
CONCENTRATOR
COMPANY
923 Glasgow Ave. • Fort Wayne, Ind., U.S.A.
CONCENCO PRODUCTS

★ *The ORIGINAL Deister Company • Inc. 1906*

GUNDLACH

Takes the Crushing Problem DOWN TO SIZE!

YOU BENEFIT...

By Control of Top Size — Crushing to size in one operation eliminates recirculating load . . . saves time and equipment . . . increases overall plant capacity.

By Less Fines — More saleable coal in stoker sizes means more dollars per ton . . . if crushing prior to washing, fewer fines means lower washing costs.

By Flexibility . . . Can handle larger lumps and frozen coal . . . hand wheel adjustment allows you to fill any order down to ¾" top size . . . orders heretofore uneconomical to fill are now yours.

By Dependability . . . Ever-increasing list of satisfied users.

By Economical Operation . . . Less maintenance . . . Less H.P. per ton of crushed coal . . . One Crusher . . . Lower initial investment . . . No wasted labor in adjusting crusher.

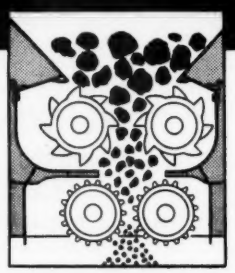
YOUR CUSTOMER BENEFITS...

By Control of Top Size . . . Less unburnt coal in ashes . . . More BTU output per ton . . . Lower ash handling costs . . . Greater overall utilization.

By Less Fines . . . Simplifies unloading . . . increases boiler efficiency.

T. J. GUNDLACH MACHINE CO.
P. O. BOX 283 • BELLEVILLE, ILL.

Division of J. M. J. Industries



Uniformity in size consist of GUNDLACH crushed coal eliminates customer complaints, gives customer satisfaction, and increases production.

If you have a crushing problem, you'll find a GUNDLACH representative as near as your telephone.

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(*Continued from previous page*)

tion concerned with developing new and improved copper products, it will seek to expand uses for the metal and its products. Dr. Clyde Williams, formerly president of Battelle Memorial Institute, will direct activities of the association which will allocate research projects to individuals, universities and established research organizations, rather than conduct its own research at this time. Any producer of copper is eligible for membership, which is presently made up of the chartering companies: American Metal Climax, Inc.; American Smelting & Refining Co.; Anaconda Co.; International Nickel Co. of Canada, Ltd.; Kennecott Copper Corp., and Phelps Dodge Corp.

All inventions, processes, developments or results of research, sponsored or underwritten by the association become its property. Whenever a patent is granted, the association will make non-exclusive licenses on uniform terms, to any person or concern which wishes to make use of patent.

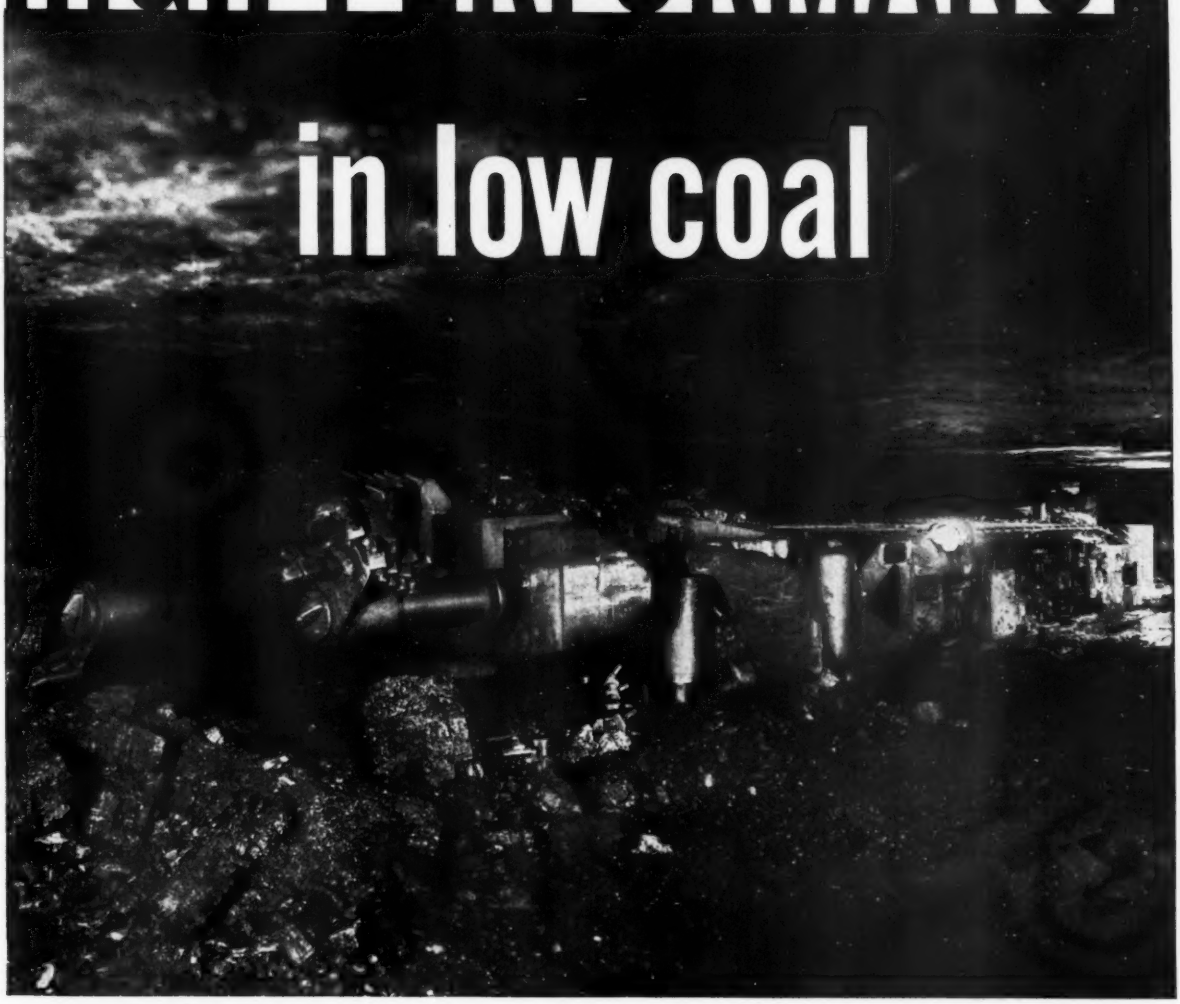
ALSO . . .

U. S. Steel Corporation's newest coal preparation plant, located at the Maple Creek mine at New Eagle, Pa., was recently put into operation. The new coal washer, which will be capable of washing coal at the rate of 800 tph when operating at peak capacity, will process coal from the new Maple Creek mine and four other U. S. Steel district mines. Coarse coal will be cleaned in a Chance cone, the intermediate sizes will be prepared on tables, while a Convertol circuit will be utilized in beneficiating the extreme fines. The processed coal will be transported to the Clairton Works for coking.

One-third of the students enrolled in mining engineering at Lehigh University, Bethlehem, Pa., are receiving scholarship grants this year. Ten of the 27 students registered as mining engineering majors have received awards averaging $1041.

A cellular steel sheet pile loading dock will be constructed at the Banner, Ill., mine of United Electric Coal Companies. The dock, located about 25 miles below Peoria on the Illinois River, will be 1400 ft long and consist of 13 cells. A belt conveyor will carry coal to the dock from the Banner mine, approximately 600 ft inland from the river.

HIGH PERFORMANCE



200% more tonnage per man as JEFFREY 86-A Colmol works in 36″ seam

Production of 860 tons of raw coal per shift has been attained, with consistent performance, giving better than 90 tons per face man over a three-month period.

The 86-A is only 25¼ inches high, makes a cut 14′ 7″ wide, is ideal for low seams 28″ to 44″ in height. All adjustments are hydraulic, and can be made quickly and accurately. Easy maneuvering contributes to the Colmol's high performance.

To move your costs down—productivity up—get Jeffrey's *system engineering* recommendations... covering equipment for mining and hauling or conveying. A system engineered job pays off in predictable results!

The Jeffrey Manufacturing Company, 958 North Fourth Street, Columbus 16, Ohio.

OFFICES: Birmingham, Alabama; Bluefield, West Virginia; Denver, Colorado; Evansville, Indiana; Harlan, Kentucky; Iron Mountain, Michigan; Pittsburgh, Pennsylvania.

CONSISTENT PERFORMANCE WITH COLMOL IN THREE-MONTH PERIOD

No. Shifts	Tonnage	Tons/shift	Tons/man
79	43,450	550	91.3

JEFFREY

MINING • CONVEYING • PROCESSING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

WHEELS OF GOVERNMENT

(*Continued from page 130*)

Welfare Committee—equally divided as to party affiliation. They would be given until January 31, 1961, to report to the Senate their findings and any legislative recommendations deemed appropriate.

Goldwater's request was embodied in a resolution referred to the Labor and Public Welfare Committee for further consideration.

MINING MACHINERY SALES INCREASE PREDICTED

Strong demands for metals and coal should result in an increase of 12 to 15 percent in shipments of mining machinery in 1960 compared to 1959, according to the Commerce Department's Business and Defense Services Administration.

A predicted 10 percent increase in electric power generation in 1960 should require an additional 20 million tons of coal with a resulting increase in the shipment of coal mining machinery, BDSA said, adding that demand for steel and other metals and minerals in 1960 should also strengthen the market for mining machinery.

BDSA reported that mine machinery sales last year were up 15 percent over 1958 despite the lengthy steel and copper strikes.

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Contractors
Exploration of Coal Properties. Guarantee satisfactory coal cores. Inside Mine Drilling. Pregrouting, Mine Shafts. Large diameter holes.
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J. W. WOOMER & ASSOCIATES
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HENRY W. OLIVER BLDG.
Pittsburgh, Penna.

SMITH GERALD HUDSON, an itinerant cattle ranch laborer and miner, was recently placed on the FBI list of "Ten Most Wanted Fugitives." Mining Congress Journal, in cooperation with the FBI, asks its readers to be on the alert for Hudson, who is known to have worked in coal mines in West Virginia, Pennsylvania and Wyoming and might now be employed or seeking employment in the mining industry.

His aliases include: Smith Girard Hudson, Smith Gerard Hudson, "Pit" Hudson, Larry King, Calvin Rhinehart, and "Smitty." He is a white American, born March 1, 1928, at Rostraver, Pa. Having a medium-stocky build, he is about 5 ft 8 in. tall, weighs 183 lb and has brown hair, blue eyes and a medium complexion. He has a 1½-in. linear scar on the first joint of his left thumb, a ½-in. scar on the outer edge of his left eyebrow and an appendectomy scar. Hudson is reportedly of average intelligence with above average mechanical aptitude, likes sports (especially swimming) and sometimes favors cowboy-type clothing.

A murderer, Hudson shot-gunned an acquaintance in 1951 following an argument in which he choked his victim. At the time of the act, he was free on bond on a charge of involuntary manslaughter. Hudson was sentenced to 20 years in prison in 1952, but escaped Pennsylvania State Penitentiary in August 1957, and has eluded capture since that time.

Hudson served in the U. S. Army for about 1½ years and was given an undesirable discharge as being unfit for military service. Considered to be belligerent and violent, especially when drinking to excess, he is believed to be armed and extremely dangerous.

Any information concerning the whereabouts of this fugitive, should be immediately relayed to the nearest office of the FBI.

Approval of a joint State-Federal project to control mine water at the Delaware-Pine Ridge mine, near Wilkes-Barre, Pa., in the northern field of Pennsylvania's anthracite region, has been announced by Secretary of the Interior Fred A. Seaton. The project calls for installing four State-owned deep-well pumps—each with a rated capacity of 6000 gpm—to supplement a pumping plant in the Delaware No. 2 shaft of the mine, owned by Hudson Coal Co. Installation of the four additional pumps will remove the threat of flooding adjacent mines—two of these being Glen Alden Corporation's Huber and Sugar Notch mines.

The executive committee of the Mine Inspectors' Institute of America have selected Louisville, Ky., as the site for its 1960 convention with headquarters at the Sheraton Hotel. The meeting and other activities will be held June 13, 14 and 15, with registration commencing on June 12.

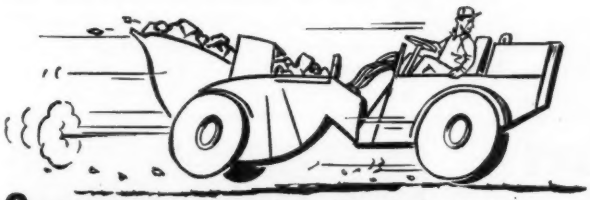
Bauxite properties, leases and underground mining equipment, of Dulin Bauxite Co., have been purchased by Reynolds Mining Corp., a subsidiary of Reynolds Metals Co. for $1,200,000. The purchase includes six tracts of land previously owned outright by Dulin in Pulaski County, Ark., and in addition, leased land in Pulaski and Saline Counties.

Columbia-Southern Chemical Corp. has announced the organization of a wholly-owned subsidiary to be known as the Columbia Cement Corp. It will own and operate the cement plant formerly owned and operated by Columbia-Southern at Zanesville, Ohio. The subsidiary will also market the cement produced at Columbia-Southern's new multimillion-dollar cement installation at Barberton, Ohio.

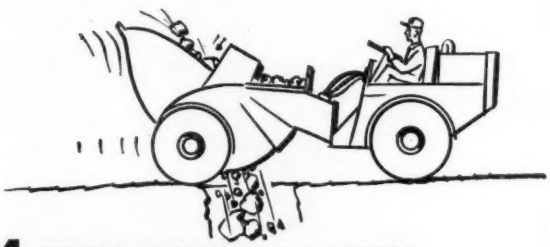
Why TRANSLOADER?

The Only Self-Loading Transport!

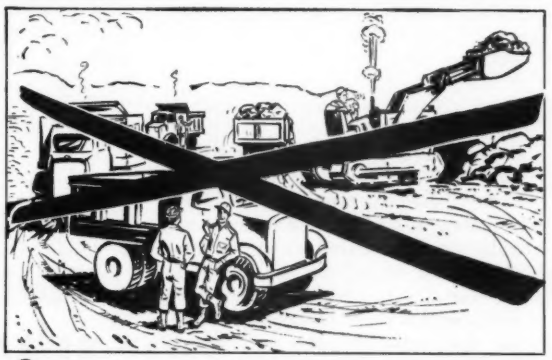
1. LOADS 6 TONS IN 49½ SECONDS!



2. TRANSPORTS AT SPEEDS UP TO 23 MPH — *either direction!*



4. DUMPS LOADS IN 15 SECONDS!



3. NEVER WAITS ON OTHER EQUIPMENT! S-D Transloader saves labor and machine costs wasted in multiple machine operation.

5. NO TURNAROUNDS REQUIRED! Returns immediately to reload! Travels at higher speeds than other equipment because of low center of gravity and articulated steering!

THIS IS WHY the S-D Transloader is more efficient than conventional equipment and methods of materials handling. But this is not all. The S-D Transloader way is the **lowest possible cost way** because:

1. **LOWEST ORIGINAL COST** for tons handled!
2. **LOWEST MAINTENANCE** due to extremely simple design and high quality of components . . . such as T-1 Steel, Cummings Engines, Clark Axles, Allison Transmissions!
3. **LEAST VENTILATION** required underground due to low horsepower ratio to work-done!
4. **LOWEST LABOR COST PER TON!** Incentive systems fit the S-D Transloader like a glove because of solo operation! Nothing could be neater than an operator loading and running a known distance to discharge **by himself!** This RELEASES SUPERVISION! S-D Transloader also ELIMINATES TASK OF TRYING TO BALANCE MEN AND EQUIPMENT WITH CONSTANTLY CHANGING SITUATIONS!

Write us today for Complete Packet of illustrated literature, data and time studies on this remarkable machine —

THE ONLY SELF-LOADING TRANSPORT! Sanford-Day Iron Works, Inc., Dale Avenue, Knoxville, Tennessee. Telephone: 3-4191

SANFORD-DAY

KNOXVILLE, TENNESSEE

The American Brass Co., a subsidiary of the Anaconda Co., has announced plans for the construction of a $1,500,000 research center at Waterbury, Conn. Ground will be broken in early summer and completion is scheduled for 1961. The new research center will include metallurgical, corrosion and chemical laboratories, and equipment for experimental production of new products as well as offices for the company's central technical staff.

The Pittston Co. has sold its subsidiary, Lillybrook Coal Co., to Pocahontas Land Corp., a subsidiary of Norfolk & Western Railway. The sale affects mines at Killarney, Lillybrook and Affinity in Raleigh County, W. Va., and the Twin Branch Coal Co. property that straddles the Wyoming-McDowell County line. The transaction involved an aggregate of 20,500 acres. The sale did not involve the Amigo Smokeless Coal Co., which remained the property of Pittston.

An illustrated brochure recently issued by Lead Industries Association shows several examples of the use of lead-asbestos pads to reduce or eliminate vibration in buildings adjacent to railways, subways, or other heavy traffic load areas. Used in the footings of such buildings, the lead pads absorb the vibration usually passed from the ground to the structural steel. Copies of *Current Practice in Isolating Buildings from Vibration with Lead-Asbestos,* (AIA No. 39D), are available on request to Lead Industries Association, 60 East 42nd Street, New York 17, N. Y.

Assets of Moore-Keppel Coal Co., Cassity, W. Va., have been sold to Connecticut General Life Insurance Co., Bloomfield, Conn. The sale included real estate and coal and other mineral rights in Randolph, Upshur and Hardy Counties.

Bridgeport Brass Co. has acquired a Government-owned metalworking plant at Warren, Ohio, and plans to turn it into an aluminum mill at a total cost of $16,000,000 to $18,000,000—this outlay to be spread over the next five years. While the plant will begin operations on rerolling only, it eventually will become an integrated mill with melting, casting and hot rolling facilities.

Tennessee Valley Authority announced its steam plants during 1959 burned 18,900,000 tons of coal. This was an increase of more than 1,500,000 tons over 1958 consumption. The total delivered cost of coal received was about $4.32 a ton. Preliminary figures indicate that TVA burned 11 percent of all the coal used by electric power systems in the Nation in 1959. It received coal from mines in Alabama, Illinois, Kentucky, Tennessee, Virginia, and West Virginia.

Aluminium Ltd. is increasing its Canadian aluminum production by 6.1 percent by the reactivation of idle potlines. The expansion will be effected by Aluminum Co. of Canada Ltd., principal operating subsidiary of Aluminium Ltd., at Isle Maligne, Quebec, Shawinigan, Que., and Kitimat, B. C., and when fully completed will add 34,500 tons to annual production. This is the third production expansion in recent months.

In addition, Aluminium Ltd. may soon acquire its first production facilities of any kind in the United States. It plans to purchase Apex Smelting Co., a major U. S. producer of aluminum foundry alloys and extrusion billets. Apex has three plants, plus a silicon smelting plant and facilities to make zinc and magnesium alloys. Since 1953 it has been a sales agent for Aluminium Ltd.

More than 2000 acres of coal properties in Monongalia and Marion Counties, W. Va., have been purchased by Consolidation Coal Co. from the Indian Creek Coal Co. of Uniontown, Pa.

A $2,000,000 facility for the production of tungsten and molybdenum is being constructed in Fairlawn, N. J., by Wah Chang Corp., New York City. It is a continuation of Wah Chang's expanding program for development and research of the atom-age metals. With 60,000 ft of manufacturing and office space, the plant will initially consolidate the company's fabrication of tungsten and molybdenum metals now conducted in two buildings in Union City and Little Ferry. The new plant is expected to start operations this spring.

Ohio River Collieries Co., Columbus, Ohio, has purchased the coal properties of Oliver Monaco, a Belmont County, Ohio, stripping concern.

WHAT ARE YOUR RESERVES?

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LET US HELP YOU FIND OUT

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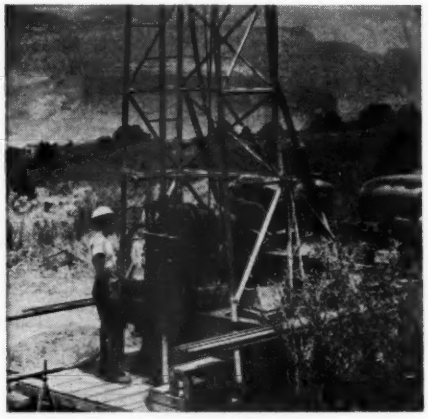

Coal in Kentucky . . . Uranium on the Colorado plateau . . . Bauxite in the Ozarks . . . Limestone in Pennsylvania . . . Copper in Montana . . . These are but a few examples of the extent of our operations. Throughout the United States and even in many foreign countries we have successfully explored and proved ore reserves for our many customers, and where normal methods have failed, special techniques have been developed. In the Gas Hills Area of Wyoming, for example, we successfully cored the loose sand and siltstone where others had failed by "freezing" the material. Our personnel and equipment are stationed throughout the United States awaiting your call.

SPRAGUE & HENWOOD, Inc.
SCRANTON 2, PA.

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NEWS and views

Texas Uranium Mill Planned

Susquehanna-Western, Inc., which has been studying south Texas uranium deposits since last summer, is making tentative plans for construction of a $2,000,000 to $2,500,000 uranium mill near Falls City, Texas. It would be Texas' first uranium mill. Company studies indicate that Karnes County deposits would support an operation for processing 200 to 250 tpd, and producing yellowcake for sale to the Atomic Energy Commission. Susquehanna-Western proposes to mine the Karnes County ores by open pit methods. The company is also studying Duval County ores which, if mined, would necessitate underground operations. Although the company is negotiating with the AEC for sale of concentrates, construction will not get underway until various land questions are resolved and enough leases obtained to assure an uninterrupted supply of ore. Susquehanna-Western is a subsidiary of Susquehanna Corp. which operates uranium mills at Riverton, Wyo., and Edgemont, S. D.

West's First Coke Plant

Food Machinery & Chemical Corp. is planning to build the West's first coke making plant on a 520-acre site near Kemmerer, Wyo. It is reported that Food Machinery will initially erect a $3,000,000 to $4,000,000 plant capable of producing about 250 tpd of coke while consuming about 500 tpd of heretofore uncokeable Western coal. The company's Westvaco Chemical Division phosphorus furnaces at Pocatello, Idaho, will utilize part of the production in the reduction of phosphate rock, and other industrial uses in the West are foreseen. One consideration in selecting Kemmerer as the plant site was its nearness to Pocatello.

Building of the facility culminates two years of pilot plant work perfecting a workable process to produce a "true" synthetic coke. The process does not require a sized coal.

Bluewater Mill Contract Extended

An extended contract for the purchase of uranium concentrates from the Anaconda Co. mill at Bluewater, N. M., has been signed with the Atomic Energy Commission. The new contract, which will terminate December 31, 1966, provides for the purchase of U_3O_8 from ore reserves developed prior to November 24, 1958, and will permit a deferral of pre-1962 production into the 1962 to 1966 period. In this connection the Bluewater mill will operate six days per week at a rate of about 3000 tpd, whereas it had been operating seven days a week at a rate of about 3500 tpd. By the terminating date of the new contract, Anaconda will have mined and processed less than half of its ore reserves developed before the November 1958 date.

Garfield Smelter to be Modernized

Modernization of the Garfield smelter, acquired by Utah Copper Division, Kennecott Copper Corp., from American Smelting & Refining Co. early in 1959, is contemplated. It is reported Kennecott proposes to spend $10,000,000 in a program that would include: Conversion of the present pre-roasting process to a direct smelting process; modernization of the materials handling system; enlargement and modernization of three reverberatory furnaces and installation of new waste heat boilers. Purchase of the Garfield smelter, at a cost of $20,000,000, was part of the company's program for integrating its copper producing facilities.

ALSO . . .

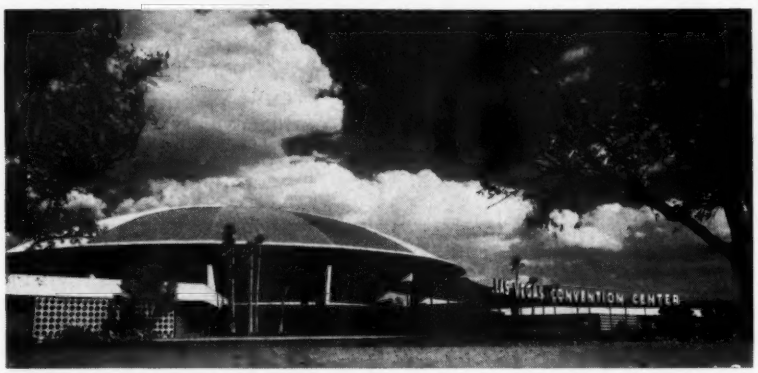
Manganese will be produced from rhodonite in the Silverton-Durango area of Colorado according to plans of Standard Uranium Corp. The company reportedly plans to erect a refining plant in 1961 at a location still to be determined to process rhodonite mined in the Silverton area. Refinery construction plans call for expenditures in excess of $6,000,000. The company is presently reopening the Sunnyside mine near Silverton and is converting and expanding their concentrator there in anticipation of treating 1500 tpd when full scale operations commence. Lead, copper, silver and gold would also be recovered during the mining operations since rhodonite is the host rock for these metals.

An unrestricted grant of $10,000 was recently received by Colorado School of Mines Foundation, Inc., from American Metal Climax Foundation, Inc. The grant will be used in a faculty improvement program—part of the school's long-range Horizon Development Plan.

Through an exchange of stock, Spokane National Mines, Inc., recently purchased the assets of Sunset Mines, Inc., in the Pine Creek district near Kellogg, Idaho. Included in the transaction were 44 claims in the Pine Creek district, the Liberal King mine, and a 150-ton flotation mill. The mill will be moved to Spokane-National's New Departure mine in Montana, which was acquired last year.

Wyoming uranium is being mined from an open pit recently developed by Western Uranium Corp. near Riverton. The ore body, which is about 7 ft thick, is overlain with about 20 ft of overburden and is located in the Fall River formation.

PLANS FOR 1960 MINING SHOW TAKING SHAPE



The new Las Vegas Convention Center, site of the 1960 Metal Mining and Industrial Minerals Convention and Exposition of the American Mining Congress, October 10–13, will provide excellent meeting room facilities and greater exhibit area than at any former AMC Mining Show. Other attractions of Nevada's fabulous man-made oasis—including delectable dining, top-flight hotel accommodations and glittering entertainment—will help to swell attendance at the year's most important mining meeting in the West

Production will be boosted from 50 tpd to 200 tpd at the Cotter Corp. uranium mill, Canon City, Colo., heretofore operated on a pilot-plant basis. It is reported that Cotter has signed a contract with the Atomic Energy Commission for the purchase by AEC of concentrates produced through February 1965.

The expansion, cost of which will exceed $1,000,000, will make the Cotter mill a full-scale processing plant for treating Front Range ore trucked from Tallahassee Creek, Marshall Pass and Jefferson County. Cotter processes ore from other producers in addition to ores from their own mining operations in Fremont, Jefferson and Gunnison Counties.

A contract to explore for lead, zinc and copper in Clear Creek County, Colo., has been approved by the Department of the Interior's Office of Minerals Exploration. Under it, Clear Creek Mining Co. of Denver has been authorized to spend $84,500 of which the Government will contribute one-half.

About 200 additional employees will be needed to place American Smelting & Refining Company's Corpus Christi, Tex., refinery at full capacity of 9000 tons per month of zinc. ASARCO has been operating the plant at about two-thirds capacity for the past two years and reports state that production is being increased. Improved demand for special high grade zinc used in die-casting was one factor leading to stepping up production.

The U. S. Bureau of Mines 1958 *Minerals Yearbook* is now available *only* from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The 2779-page edition consists of three volumes: Vol. I—Metals and Nonmetals, $4.00; Vol. II—Fuels, $2.25; and Vol. III—Area Reports, $3.75. Individual chapters comprising each volume are available separately from the Superintendent of Documents at prices ranging from 5 cents to 35 cents. The Minerals Yearbook is not sold by the Bureau of Mines.

The Jeffrey City, Wyo., uranium mill of Western Nuclear, Inc., will supply two metric tons of yellowcake to a Japanese company, Japan Atomic Fuels Corp., under an agreement recently reached between the two organizations. Western Nuclear will ship the concentrates when approval of the sale is received from the Atomic Energy Commission. The sale is of interest to U. S. producers in that heretofore domestic uranium has not been able to compete favorably on the world market. Western Nuclear has been bidding against Canadian and South African producers to supply uranium oxide for experimental atomic reactors in Japan.

A $550,000 transaction between Homestake Mining Co. and Lance Corp., wholly owned Sabre-Pinon Corp. subsidiary, has given Homestake a 25 percent interest in 16,000 acres of uranium mining properties of Lance in McKinley Co., N. M. Under the arrangement, Homestake also acquired a 25-percent interest in Lance's Section 18 mine which is rated to produce at 300 tpd. Sabre-Pinon reports that 140,000 tons of ore averaging 0.35 percent U_3O_8 have been blocked out in Section 18. The recent transaction extends Homestake's participation to include all Sabre-Pinon and subsidiary properties in the Ambrosia Lake area. Sabre-Pinon holds 75 percent and Homestake 25 percent interest in five mines on Sabre properties, Sections 15, 23, and 25, T14N, R10W, and Lance mines on Sections 12 and 18, T15N, R13W, as well as undeveloped properties in these sections.

Merger of Lucky Mc Uranium Corp. into Utah Construction & Mining Co. was recently voted by directors of Lucky Mc. Execution of the merger is dependent upon approval of Lucky Mc shareholders. Utah Construction has 60 percent control over the company, which operates one of the largest uranium mines and mills in the nation in the Gas Hills area of Wyoming.

Exploration of iron ore properties in the Brighton mining district of Utah will be undertaken by Utah Development Co. as a result of a leasing arrangement recently signed with both Great Western Mines, Inc., and Miller Hill Mining Co. Under the arrangement, Utah Development, a wholly-owned subsidiary of Utah Construction & Mining Co., will explore about 3000 acres of patented mining claims in the Brighton, American Fork Canyon and Snake Creek districts by geophysical and drilling methods. The work calls for minimum expenditures of $70,000 for exploration prior to January 11, 1963. Utah Development holds options on the properties for royalty payments or for outright purchase at a figure in excess of $2,000,000.

There's a reason WHY in MacWHYte Wire Rope*

It brings out the best in your equipment!

Just as you use specialized equipment for a particular job, it pays to use the right kind of wire rope designed for that equipment.

All wire rope isn't the same. There are changes in the construction of wire rope . . . which aren't obvious to the eye . . . but can seriously affect the way it will work on your equipment. Because all equipment isn't the same, different types of rope are required because of basic design variations.

With this in mind, you can see the reason "why" Macwhyte offers such a wide variety of wire rope:

* Every foot of wire in Whyte Strand is specially drawn, cold-worked by Macwhyte in their own wire mill. Complete processes — from raw material to finished wire for rope — are under the watchful eyes of Macwhyte metallurgists.

* Product engineers determine the exact number, size, and relationship of the wires needed to meet the requirements of your equipment. You're sure of the correct size, strength, and flexibility.

* Special lubrication is available in accordance with the needs of the equipment or the type of service in which the rope will be used. The tenacious lubricants provide just the necessary protection — are unaffected by heat or cold, dry or wet conditions.

* Entire wire and rope mill operations are concentrated on the making of wire rope in a thousand and one sizes, grades, and types . . . to give you the rope you need.

Result: Whyte Strand wire rope is literally "custom made" for strip shovels, loading shovels, draglines, shaft hoists, haulage, underground scrapers, loaders, mining machines, conveyors, car pullers, and blast hole drills. Ask for new bulletin 6025 giving complete listings of Whyte Strand wire rope. 207

MACWHYTE Wire Rope COMPANY

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manufacturers forum

Diesel Tractor

POWERED BY A SIX-CYLINDER, FOUR-CYCLE, direct-starting engine known as the DT-817 turbocharged engine, the International TD-25 diesel tractor is the most powerful crawler ever produced by International Harvester Co., 180 N. Michigan Ave., Chicago, Ill. The DT-817 engine is said to develop 230 net hp at the flywheel at 1500 rpm.

The TD-25 is available in either a torque converter or a gear-drive version. The former offers four speeds forward and reverse and has a drawbar pull up to 70,000 lb at 0.75 mph, with adequate weight and traction. Operating weight is 46,000 lb. The gear-drive unit weighs 45,500 lb and has a 46,700 lb drawbar pull in first gear at rated governed speed. It has eight speeds forward and reverse.

Ventilating Flow Instruments

MEASURING AIR VELOCITY IN MINE AIRWAYS is the major intended use of the Davis ventilating flow instruments distributed by EPIC, Inc., 150 Nassau St., New York 38, N. Y. Several models are available covering ranges from 30 up to 6000 fpm.

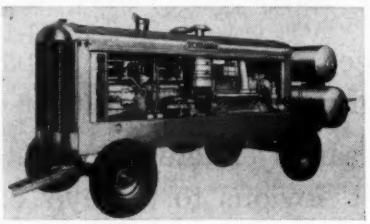
Dust-Soaking Fog

HIGH PRESSURE FOGGING for dust control plus application as auxiliary fire fighting equipment has been designed into a single tank truck unit by Lake Shore, Inc., Iron Mountain, Mich. Developed for heavy service over rugged terrain, the Lake Shore tank truck is built with both horizontal and longitudinal baffles and bulkheads to prevent sudden load shift. High pressure fogging equipment is stored in a nested compartment in the trailer nose for safety and cleanliness.

The unit uses a straight centrifugal pump with an output of 120 gpm at pressures of 120 psi, producing high density fog which is dispersed through nine nozzles at the rear of the tank unit; tank capacity of 3800 gal provides water supply adequate for fire underwriter requirements.

Air Compressor

INCREASED POWER, longer life, and minimum maintenance and servicing are features claimed by Schramm, Inc., 900 E. Virginia Ave.,



West Chester, Pa. for its air compressor, the Model 600-TC, which is being offered as the standard 600 cfm unit in the company's line of Unistage Portable Air Compressors.

This equipment is driven by Schramm's version of the turbocharged UDT-1091 International diesel engine which reportedly puts out over 25 percent more horse power than other engines of similar capacity. This is said to maintain the unit's performance at a high level even under extreme conditions of altitude and temperature. Reduced maintenance and servicing is claimed because the low operating speed of 1200 rpm affords longer life and reduced wear.

Air Hoist

MOUNTED ON A SKID-TYPE BASE for portability, an air-powered hoist by Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa., offers a choice of several throttle and brake systems that make it adaptable for use in such divergent areas as mine shifts, car spotting at industrial plants and mines, and large spotting at docks. The hoist has a lifting capacity ranging from 27,000 lb at 37 fpm to 3700 lb at 220 fpm. The rope drum has a capacity of 2300 ft of ¾-in. wire rope and is driven by a five-cylinder, radial air motor (10, 17 or 23 hp) through a multiple roller chain.

De-rusting and De-scaling Gun

OPERATING ON COMPRESSED AIR, the Von Arx air gun is a tool for de-rusting, de-scaling, cleaning and surface preparation of practically all materials.

Compressed air drives hardened steel needles, which, with their impact on a spring-loaded recoil movement reciprocate rapidly, striking the surface being worked, thus removing scale, rust and paint. Air continually flows over the working surface removing loosened particles. The ability of the needles to conform to the contour of a surface reportedly makes the air gun most effective in cleaning and descaling uneven surfaces. Needle diameters can be changed and are available in three sizes—two, three and four mm. In addition to hardened steel needles, non-sparking (copper beryllium) and stainless steel are also available. For additional information, write to Swissair Tool Corp., 7775 Sheridan Drive, Buffalo 21, N. Y.

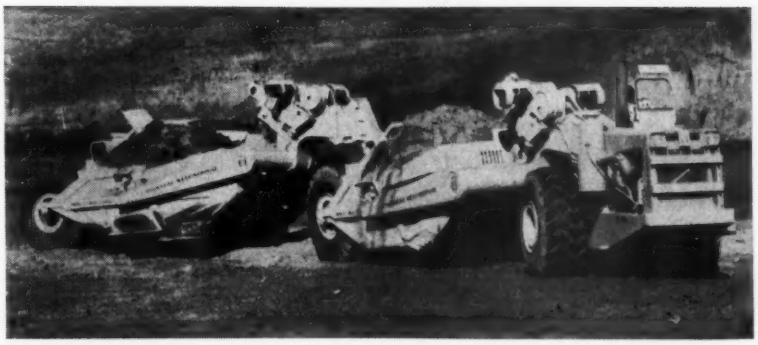
Extensible Mine Conveyor

CAPABLE OF OPERATING AS LONG AS A WEEK or more without being moved, an extensible mine conveyor by Hewitt-Robins, Inc., 666 Glenbrook Rd., Stamford, Conn., is said to reduce the "down-time" of constantly moving conveyors to keep pace with continuous mining machinery.

The Hewitt-Robins unit is designed for use in underground coal and hard rock mining, and is comprised of a belt which rides on idlers mounted on sled-like skids spaced at five-ft intervals. Wire ropes hold the skids in alignment, and the conveyor may be constructed with as many as 200 skids, making a unit 1000 ft long. The equipment is located behind the mine loader which receives the material from the continuous mining machine. An electro-hydraulic tractor with crawler traction is attached to each end of the conveyor, exerting constant tension on the belt to keep it taut.

Variation in the distance from the conveyor loading point to discharge is made possible by a traveling tripper. The conveyor is claimed to operate at a rate of 400 tph for 70 hrs or more without moving the equipment. Tractors can tow the entire unit to a new work area as that becomes necessary.

Tandem Scrapers



FLEXIBILITY is claimed by LeTourneau-Westinghouse Co., 2301 NE Adams St., Peoria, Ill., to be an important factor in the use of its recently announced tandem scrapers.

Coupling or uncoupling the second scraper reportedly can be accomplished in 30 minutes or less due to a single hitch pin forming the mechanical connection, while quick connecting plug-ins provided the hook-up for electric cables and air hoses. The company points out that the equipment owner can double or halve his equipment capacity at will to tailor the machines for different types of jobs or changing conditions on the same job.

L-W says the tandem principle is not new but believes its approach makes the idea practical because it has decreased the awkwardness and lack of maneuverability of these vehicles caused by their extreme length, plus the complication of running long reeves of cable from rear scrapers to a power control unit on the prime mover.

Further, the manufacturer pointed out, any Tournapull scraper combinations already in the field built since 1947, can be easily tandemized at modest cost. Tandems are currently available behind all three sizes of the company's two-wheel Tournapull prime movers, as well as with the recently introduced four-wheel Speedpull. Total capacities with the tandems range from 18 cu yd in the D size to 56 cu yd in the Model B.

—ANNOUNCEMENTS—

Ellis B. Gardner, has been appointed executive vice president of **Hewitt-Robins, Inc.,** according to an announcement made by Austin Goodyear, president. Gardner, who joined the company in 1946 has been controller, and vice president and treasurer, and since 1955 has headed the company's foam products division. Prior to joining Hewitt-Robins, he was with General Electric.

Concurrent with the Gardner promotion, Hewitt-Robins also announces the appointment of **Pitt B. Harris,** in sales work for the company since 1947, as acting general manager, foam products division.

F. Laurence Chandler, formerly assistant secretary and assistant treasurer of **Anaconda Sales Co.,** has been elected secretary-treasurer. Mr. Chandler, in the metals industry since 1934, succeeds **Foster R. Bowlby** who has retired. Anaconda Sales Co., a wholly-owned subsidiary of **the Anaconda Co.;** transacts all sales of metals produced by the parent company and other Anaconda subsidiaries and affiliates.

Retirement of **John E. Goble** as president of **National Tube Division of United States Steel Corp.,** and the appointment of **Henry J. Wallace** as his successor, has been announced by **Leslie B. Worthington,** president of **U. S. Steel.**

At the same time it was announced that **William F. McConnor,** executive vice president of the Tube division since 1950, would also retire and would be succeeded by **Edmund G. Price.**

Robert J. McGinnis has been appointed senior sales representative for the **Mining Tool Division of Kennametal Inc.** McGinnis joined Kennametal in 1945 as a salesman and has been a district sales supervisor for the last 12 years. His new duties will include market studies and customer relations on a nation-wide basis. **Dick W. Welch** has been appointed district sales manager for the Northern District succeeding McGinnis.

Jeffrey Manufacturing Co., Columbus, Ohio, announces two new developments in their sales organization. **Peter Ambrosiani** has been appointed manager, western territory, Mining Division with headquarters at the E. C. Horne Machinery Co., Denver, Colo. Ambrosiani, with eastern coal field experience, will service the western trading area for Jeffrey. The second announcement concerns opening of a new branch office in Los Angeles by the Industrial Division to be headed by **Keith Beachler,** formerly of the company's San Francisco district office.

Jefferson J. Davis, formerly vice president in charge of **Product Divisions at Electric Steel Foundry Co.,** has been named executive vice president. Joining ESCO-Seattle as office manager in 1936, Davis served successively as manager at ESCO-Eugene, manager of Logging, Sawmill, Crushing and Construction Equipment Divisions. In September, 1954, he was promoted to vice president in charge of Product Divisions.

Catalogs & Bulletins next page

CATALOGS & BULLETINS

GENERAL PURPOSE CONTROL CATALOG. *General Electric Co., Schenectady 5, N. Y.* GEC-1260D is the catalog number of a 72-page publication that contains information on the complete line of control devices manufactured by the General Purpose Control Dept., of General Electric Co. These include such varied devices as both manual and magnetic motor starters, contactors, relays, solenoids, limit switches, push buttons. Wiring diagrams, dimensions and application information are all included in the catalog to facilitate its use.

FIRST AID CONTAINER. *Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.* A flip-top box for multiple-use first-aid units is featured in Bulletin No. 0401-8, which highlights construction features of the container, including resistance to tearing after frequent use, sealed-in protection against dust or grime, and improved convenience in extracting items. First-aid items in the new package are ammonia inhalants, iodine brushes, merthiolate swabs, waterproof adhesive bandages, plastic adhesive bandages, two-in. compress bandages, Foille liquid for burns in two sizes, and Foille ointment for burns.

REBUILD WELDMENT WALL CHARTS. *Dept. A, American Manganese Steel Division, American Brake Shoe Co., 389 E. 14th St., Chicago Heights, Ill.* A "how-to" wall chart in color from Amsco gives step-by-step instructions for replacing tractor grouser bars. It also includes detailed ordering information for manganese or carbon steel bars covering all leading makes of tractors. A similar chart provides instruction and specifications covering two types of dipper tooth repointer and repointer bars.

FORGINGS. *ALCO Products, Inc., P. O. Box 1065, Schenectady, N. Y.* The fall-winter issue of "ALCO Review," product publication of this company, features a five page article about the firm's Hi-Qua-Led steel forgings. Physical comparisons of the new free-machining product with regular grade steels of comparable grades are presented and there is also comparative data on yield and tensile strengths, ductility, fatigue strength and tool wear.

ARCAIR NEWS LETTER. *Arcair Co., P. O. Box 431, Lancaster, Ohio.* New literature for Arcair customers is available in the form of a special quarterly publication called "Arcair News". Designed to keep users abreast of applications, developments and new product innovations, each issue contains interesting case studies and other information to illustrate the wide range of industrial duties performed with Arcair torches. Companies sending for the publication are requested to send in their name and address, with individuals including their name and title.

FRONT END LOADER. *The Eimco Corp., P. O. Box 300, Salt Lake City 10, Utah.* Bulletin L-1092 contains facts and specifications on Eimco 126 front end loader, a crawler unit equipped with a 205-hp diesel engine teamed with Eimco's "Unidrive" transmission, single stage torque converter and dual final drives.

DIAMOND DRILL BITS. *Anton Smit & Co., Inc., 111 Eighth Ave., New York 11, N. Y.* Detailed information, including specifications, assembly data and prices, on ASCO diamond drill bits is presented in Catalog No. 502.

TIMING BELT DRIVE. *Dept. P59, R & J Dick Co., Inc., Totowa, N. J.* Entitled "Dick Engineering Data for Stock 'Timing' Belt Drives," Catalog No. DTE-1 contains timing belt drives data, presenting detailed information on the selection, design, installation, operation and maintenance of this equipment. Typical uses mentioned and illustrated range from electric typewriters to high torque applications in driving heavy industrial equipment.

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Reg., U.S. and foreign Pat. Offices

In Western States

PATTIN expansion shells are available and serviced exclusively through Colorado Fuel and Iron Corporation, Denver, Colorado. Western mining companies may contact them direct for information and consultation.

Most mines can Roof Bolt

Effectively and Profitably....

WHILE each mine may be different in physical characteristics, in method of operation or types of equipment used—all mines have one problem in common—the problem of keeping the roof in place.

Hundreds of mines, with all different kinds of roofs, have proved that roof bolting is the best form of roof control. They have also found that bolting leads to increased safety, better ventilation and greater production efficiency. Roof bolting offers so many profitable production advantages it justifies any mine, now using conventional timbering methods, making comparative roof support tests. Bolting tests can be made at very little cost.

To be as effective as possible—roof bolting calls for thorough knowledge of the roof strata—well planned bolting patterns and cycles—proper selection of bolts and shells and adequate supply and service program. Being "The Pioneer in Roof Bolting"—PATTIN MFG. COMPANY, staffed with experienced roof bolting, mining engineers, is capable of meeting every requirement for quality products and service. Your phone call or letter will get immediate attention.

Shown above is the outstanding PATTIN style D-1 expansion shell. Samples of the "D-1" or "D-2" shells will be furnished upon request.

PATTIN MANUFACTURING COMPANY

"72nd Year"

MARIETTA, OHIO

Now—more light, less weight, longer life with

NEW EDISON MODEL S ELECTRIC CAP LAMP

MSA announces another new *high* in lighting efficiency in the world's most popular cap lamp. Increased light output of the new Edison Model S Lamp assures greater safety for the miner, more tons per shift for the operator. Let's face a fact: Dimness costs money. *Fair* lighting does only a *fair* job. Maximum lighting—the brilliant, unfailing Edison Model S kind—helps get jobs done with top speed and safety. And the simplified method of charging new Model S Batteries—with the AUTOMATIC LOW-VOLTAGE SYSTEM—is convenient, thrifty and highly efficient. Lets miners take their lamps and rack them—quickly—without loss of time or waste motion. When planning a new lamphouse installation or modernizing your present one, call in the MSA Representative. MSA can help you solve your lighting problems.

Newly issued U.S. Bureau of Mines Approval 6D-31, April 16, 1959.

MSA SAFETY EQUIPMENT HEADQUARTERS

MINE SAFETY APPLIANCES COMPANY • 201 North Braddock Avenue, Pittsburgh 8, Pennsylvania

MINE SAFETY APPLIANCES CO. OF CANADA, LIMITED • Toronto, Calgary, Edmonton, Montreal, Sydney, Vancouver, Winnipeg

Look how small the headpiece is. Weighs only a few ounces. Feels even lighter on the head. You get a clear, sharp spot every time.

Increase in working light appeals to me. This new Edison Model S gives 15% more than we ever had before. And they didn't cut their bulb service life rating to do it. The double filament bulb means we'll always have working light to finish the shift. Each filament of the Edison Model S krypton-gas-filled bulb has a 400-hour designed life.

Just watch the improvement in our safety and tonnage reports. More light. Less weight. Longer life. Even the battery's better. It has a new active material that boosts service life. They went all-out to meet the miner's needs with this one.

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